# Effect of sowing date and weed control method on the growth and yield of soybean

Utjecaj roka sjetve i načina suzbijanja korova na rast i prinos soje

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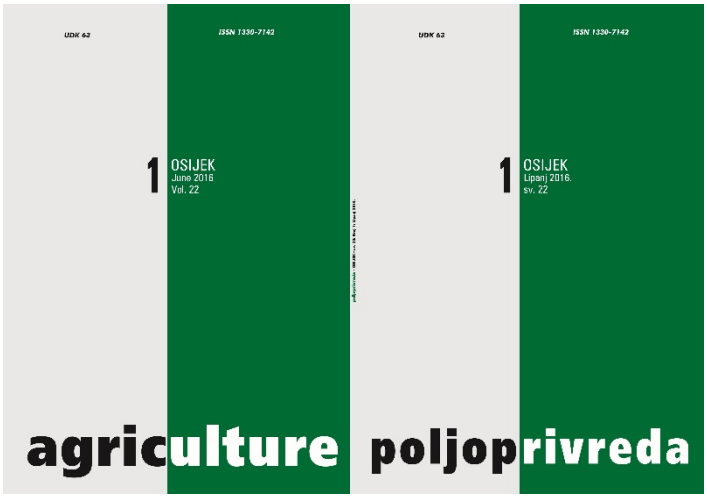
**Poljoprivreda/Agriculture**

ISSN: 1848-8080 (Online)
ISSN: 1330-7142 (Print)

http://dx.doi.org/10.18047/poljo.22.1.3




**Poljoprivredni fakultet u Osijeku, Poljoprivredni institut Osijek**
Faculty of Agriculture in Osijek, Agricultural Institute Osijek

ISSN 1330-7142
*UDK: 633.853.52:631.53.4+632.5*
DOI: 10.18047/poljo.22.1.3

# EFFECT OF SOWING DATE AND WEED CONTROL METHOD ON THE GROWTH AND YIELD OF SOYBEAN

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Original scientific paper
*Izvorni znanstveni članak*

**SUMMARY**

***Sowing date and weed management play a significant role in determining soybean growth, development and seed yield. Results showed that different sowing date and weed control methods had significant effect on relative weed density, weed biomass, weed control efficiency, plant height, dry weight plant$^{-1}$ and seed yield of soybean. Among the infested weed species in the experimental field the dominant weeds were Lindernia procumbens (44.78%), Echinochloa colonum (26.39%) and Cynodon dactylon (16.30%). The results also revealed that early sowing (2 January) brought about the highest seed yield (2.17 t ha$^{-1}$) and sowing delay (1 February) resulted in the lowest yield (1.64 t ha$^{-1}$). Two times hand weeding (20 and 40 DAS) controlled the weeds most effectively and led to highest seed yield (2.23 t ha$^{-1}$) which was statistically similar (2.19 t ha$^{-1}$) with herbicide application. Combination effect showed that the highest seed yield (2.50 t ha$^{-1}$) was obtained from 2 January sowing when the crop was weeded by hand at 20 and 40 DAS.***

***Key-words: relative weed density, soybean, sowing date, weed control efficiency, weed species***

## INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is a leguminous crop and belongs to the family Leguminosae and sub-family Papilionaceae. It is the most important grain legume of the world and a new prospective crop for Bangladesh (Rahman et al., 2011). Although the climatic and the edaphic conditions of Bangladesh are favorable for soybean production; the yield of this crop is very low compared to other soybean growing countries. Among the different reasons for low yield is the improper agronomic management such as sowing at wrong time. Planting date is an important factor influencing soybean growth and yield (Calvino et al., 2003; Bastidas et al., 2008). If planted too early, soybean may have poor emergence or limited growth because of high temperature. Namely, when soybeans are exposed to days shorter than critical length, they progress rapidly to maturing. If this occurs before the plant reaches an adequate size, the soybean is stunted and gives low yield (Boquet and Clawson, 2007).

The reduction in soybean yield due to weed infestation varies from 20-77% depending on the type of soil, season and intensity of weed infestation (Daugovish et al., 2003; Kurchania et al., 2001). The higher reduction in seed yield due to weeds is more as compared to other factors limiting the soybean production. It has been estimated that soybean growers lost an average of 1.8 million US$ per year due to yield reductions from weed infestation (Anderson and Bridges, 1992). Under these circumstances effective weed control methods needed to be developed to reduce yield loss due to weed infestation but researches in this line are highly scarce in Bangladesh. Therefore, the present research work was undertaken with a view to find out the optimum sowing date and effective weed control methods to ensure soybean growth and yield.

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## MATERIAL AND METHODS

The field experiment was conducted at the Agronomy research field, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh located at 23°74'N latitude and 90°35'E longitude at an altitude of 8.6 meter above the sea level during the period from December 2012 to June 2013. The soil of the experimental site was silt loam in texture, with pH 6.4, organic carbon 0.68%, total nitrogen 0.08%, available phosphorus 10.99 mg/kg, available potassium 0.05 meq/100 g and available sulphur 10.5 mg/kg. The climate of this area is subtropical with average monthly maximum and minimum temperature, rainfall, relative humidity of 29.45°C and 13.86°C, 62.34 mm, 61.67%, respectively. There were four sowing dates *viz.,* 18 December ($S_1$), 2 January ($S_2$), 17 January ($S_3$), 1 February ($S_4$); and four weed management treatments i.e., no weeding (control), hand weeding at 20 and 40 DAS ($W_1$), hand hoe weeding at 20 and 40 DAS ($W_2$) and chemical control by Whip Super 9 EC (Fenoxaprop-P-ethyl) @ 615 ml $ha^{-1}$ at 20 DAS ($W_3$) as post-emergence herbicide. The experiment was laid out in a split plot design with three replications where sowing date was placed along the main plot and weeding treatments were placed in the sub plot. BARI Soybean-6 was used as the test variety. Seeds were sown in 30 cm apart rows and 5 cm within lines by following as per treatment dates. The data on weed infestation were collected from each unit plot at 20 DAS and up to 60 DAS at 20 days interval. A plant quadrate of 1.0 $m^2$ was placed at three different spots of 10 $m^2$ of the plot. The middle quadrate was remained undisturbed for yield data. The infesting species of weeds within the first and third quadrate were identified and their number was counted species wise alternately.

Relative weed density was calculated by using the following formula:

$$\text{RWD} = \frac{\text{Density of individual weed species in the community}}{\text{Total density of all weed species in the community}} \times 100$$

Weed control efficiency was calculated with the following formula developed by Sawant and Jadav (1985):

$$\text{Weed control efficiency (WCE)} = \frac{DWC - DWT}{DWC} \times 100,$$

where, DWC = Dry weight of weeds in unweeded treatment and DWT = Dry weight of weeds in weed control treatment

### Data analysis

Collected data on different parameters were statistically analyzed by using MSTAT-C (Russel, 1994) program. Mean differences among the treatments were compared by Least Significant Differences (LSD) at 5% level of probability.

## RESULTS AND DISCUSSION

### Infested weed species in the experimental field

Weed growth is comparatively more abundant and quicker than those of the desired crop plants whereas weeds are the most competitors in their early growth stages than the later ones. About twenty major weed species belonging to eleven families were found to infest the experimental crop (Table 1) among which fifteen species were broad leaved, four grasses and one was sedge. The most important weeds of the experimental plots were *Lindernia procumbens, Echinochloa colonum*, *Vicia sativa, Cynodon dactylon, Digitaria sanguinalis, Chenopodium album, Cyperus rotundus, Eleusine indica*. Guliqbal (2005); Idapuganti et al. (2005); Kushwah and Vyas (2005); Malik et al. (2006) found *Acalypha indica*, *Caesulia axillaris*, *Celosia argentea*, *Commelina benghalensis*, *Cyperus iria*, *Cyperus rotandus*, *Dactyloctenium aegyptium*, *Digera arvensis*, *Digitaria sanguinalis*, *Echinochloa colona*, *Eragrostis piolsa*, *Phyllanthus niruri*, *Trianthema portulacastrum* in the soybean field. Abundance of weed species varied due to seasonal variation and location whereas weeds appear much more adapted to agro-ecosystems than our crop plants. Without interference by man, weeds would easily wipe out the crop plants. This is because of their competition for nutrients, moisture, light and space which are the principle factors of crop production.

**Table 1. Weed species determined in the experimental plots of soybean at different sowing date**

*Tablica 1. Korovne vrste utvrđene na pokusnim parcelama soje pri određenim rokovima sjetve*

| SL. No. | Local name | English name | Botanical name | Family | Types |
|---|---|---|---|---|---|
| 1 | Durba | Bermuda grass | *Cynodon dactylon* | Poaceae | Grass |
| 2 | Bathua | Lambs quarter | *Chenopodium album* | Chenopodiaceae | Broad leaf |
| 3 | Mutha | Nutgrass | *Cyperus rotundus* | Cyperaceae | Sedge |
| 4 | Khetpapri | Prostate false pimpernel | *Lindernia procumbens* | Scrophulariaceae | Broad leaf |
| 5 | Malncha | Alligator weed | *Alternanthera philoxeroides* | Amaranthaceae | Broad leaf |
| 6 | Bon Masur | Wild lentil | *Vicia sativa* | Fabaceae | Broad leaf |
| 7 | Boro Anguli | Scrab grass | *Digitaria sanguinalis* | Poaceae | Grass |
| 8 | Khude Shama | Jungle rice | *Echinochloa colonum* | Poaceae | Grass |

| SL. No. | Local name | English name | Botanical name | Family | Types |
|---|---|---|---|---|---|
| 9 | Chapra | Indian goosegrass | *Eleusine indica* | Poacease | Grass |
| 10 | Hatishur | Wild clary | *Heliotropium indicum* | Boraginaceae | Broad leaf |
| 11 | Bon Mula | Wild raddish | *Raphanus raphanistrum* | Brassicaceae | Broad leaf |
| 12 | Shetlomi | Common cudweed | *Gnaphalium luteoalbum* | Asteraceae | Broad leaf |
| 13 | Bon sarisha | Wild mustard | *Brassica kaber* | Brassicaceae | Broad leaf |
| 14 | Chanchi | Sessile joyweed | *Alternanthera sessilis* | Amaranthaceae | Broad leaf |
| 15 | Chochalo Begun | Spiny night shade | *Solanum rostratum* | Solanaceae | Broad leaf |
| 16 | Foska begun | Clammy ground chery | *Physalis heterophylla* | Solanaceae | Broad leaf |
| 17 | Kheshuti | White eclipta | *Eclipta prostrata* | Asteraceae | Broad leaf |
| 18 | Arich | Tora weed | *Cassia tora* | Fabaceae | Broad leaf |
| 19 | Shushni Shak | 4-leaved water clover | *Marsilia quadrifolia* | Marsileaceae | Broad leaf |
| 20 | Helencha | Harkuch | *Enhydra fluctuans* | Asteraceae | Broad leaf |

**Relative weed density (%)**

Weed competes with another weed plants for their existence. Some weed species were found to dominate the experimental field at different dates (Table 2). From the Table it is observed that Barmuda grass dominated at early period i.e., before mid January whereas population intensity of Prostate false pimpernel was increased up to the end period (mid January to April) of the experiment. This might be due to crop-weed competition, weed-weed competition or allelopathic effect (chemical secretion of one plant that inhibits the growth of others) of one plant to others. Although, occurrence of weed in the crop field mainly depends on various environmental factors (climate, rainfall etc.) and abiotic factors (soil types, topography of land etc.) broad leaf and grass weeds dominated the field during the experimental period. Relative density of several weed species decreased at later stages due to their completion of life cycle.

**Table 2. Relative density (%) of different weed species at different date after sowing in the experimental area**

*Tablica 2. Relativna gustoća (%) različitih vrsta korova prema određenom datumu nakon sjetve na pokusnim parcelama*

| English name | $S_1$ = 18 December, 2012 | | | $S_2$ = 2 January, 2013 | | | $S_3$ = 17 January, 2013 | | | $S_4$ =1 February, 2013 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative weed density (%) at | | | Relative weed density (%) at | | | Relative weed density (%) at | | | Relative weed density (%) at | | |
| | 20 DAS | 40 DAS | 60 DAS | 20 DAS | 40 DAS | 60 DAS | 20 DAS | 40 DAS | 60 DAS | 20 DAS | 40 DAS | 60 DAS |
| Bermuda grass | 13.52 | 12.00 | 6.16 | 15.73 | 12.89 | 12.56 | 16.30 | 9.32 | 9.49 | 6.99 | 5.91 | 7.49 |
| Lambs quarter | 12.96 | 2.01 | 1.43 | 7.54 | 4.15 | 5.07 | 4.05 | 0.80 | 0.20 | 0.20 | 0.00 | 0.00 |
| Nutgrass | 13.11 | 0.00 | 5.23 | 9.73 | 10.39 | 9.04 | 13.32 | 13.20 | 9.20 | 14.20 | 11.34 | 3.60 |
| Prostate false pimpernel | 10.46 | 27.32 | 23.54 | 18.50 | 17.88 | 14.93 | 16.16 | 28.78 | 38.78 | 32.81 | 41.03 | 44.78 |
| Alligator weed | 8.14 | 0.10 | 0.00 | 4.60 | 3.33 | 7.07 | 6.05 | 5.60 | 2.60 | 4.30 | 1.04 | 0.00 |
| Wild lentil | 9.00 | 6.45 | 3.17 | 0.00 | 5.82 | 6.68 | 7.00 | 1.20 | 0.12 | 1.20 | 0.00 | 0.00 |
| Scrab grass | 6.22 | 16.46 | 8.11 | 9.36 | 6.86 | 11.79 | 5.05 | 6.92 | 8.92 | 7.18 | 9.92 | 10.63 |
| Jungle rice | 0.00 | 26.39 | 25.44 | 10.00 | 9.14 | 9.63 | 8.01 | 11.14 | 10.82 | 9.23 | 12.44 | 12.12 |
| Indian goosegrass | 0.00 | 0.00 | 0.00 | 6.20 | 4.15 | 7.86 | 5.00 | 6.34 | 3.64 | 8.34 | 4.64 | 11.46 |
| Wild clary | 0.00 | 0.40 | 1.06 | 0.00 | 3.12 | 3.79 | 3.40 | 3.70 | 4.70 | 3.70 | 6.33 | 2.54 |
| Wild raddish | 0.00 | 0.00 | 1.34 | 0.00 | 3.72 | 0.00 | 1.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Common cudweed | 0.00 | 0.08 | 12.00 | 2.20 | 0.00 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wild mustard | 6.00 | 7.85 | 4.00 | 4.86 | 3.14 | 2.16 | 2.00 | 1.09 | 0.50 | 0.30 | 0.00 | 0.00 |
| Sessile joyweed | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 1.30 | 1.30 | 3.10 | 2.13 | 3.33 |
| Spiny night shade | 0.00 | 0.16 | 0.50 | 0.00 | 3.33 | 3.15 | 1.41 | 4.30 | 4.30 | 3.40 | 2.30 | 1.92 |
| Clammy ground chery | 0.00 | 0.16 | 0.00 | 0.00 | 3.33 | 3.15 | 0.90 | 1.20 | 2.10 | 1.20 | 1.20 | 0.08 |
| White eclipta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.54 | 0.08 | 0.64 | 0.76 |
| Tora weed | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.33 | 0.06 | 0.63 | 0.86 |
| 4-leaved water clover | 0.00 | 0.24 | 0.14 | 0.00 | 0.12 | 0.00 | 0.00 | 0.30 | 0.33 | 0.10 | 0.43 | 0.43 |
| Harkuch | 0.00 | 0.08 | 0.00 | 0.03 | 0.02 | 0.03 | 0.00 | 0.40 | 0.70 | 0.20 | 0.02 | 0.00 |

**Weed dry matter (g $m^{-2}$)**

The significant effect on weed dry weight was found due to different sowing date and also for different weed control methods at 40 and 60 DAS (Table 3). Weed dry matter increased with time advancement. Late planting increased the accumulation of weed dry matter and early planting decreased the amount of dry matter accumulation. Suitable vegetative growth period provided a good chance for the soybean to produce the highest dry weight and to increase its produced biomass as much as possible. Due to lack of time for dry matter accumulation in plant, late planting dates do not provide the plant with the necessary time for its increase. So, the total dry weight in soybean is less than that of earlier planting dates. Late planting provides the better chance for weed growth which favors more dry matter accumulation in weed. The results were consistent with the findings of Kouchaki (1994). On the other hand, maximum weed dry matter produced due to no weeding while minimum was found due to hand weeding at 20 and 40 DAS. Weed dry weight significantly influenced by the combination of different sowing date and weed control method at 40, 60 DAS (Table 3). The highest amount of weed dry matter was achieved at 40 and 60 DAS of sowing seeds on 1st February combined with no weeding produced. The lowest was found out from the treatment combination of 2nd January seed sowing and hand weeding at 20 and 40 DAS.

**Table 3. Effect of sowing date and/or weed control method on weed dry weight and weed control efficiency at different days after soybean sowing**

*Table 3. Utjecaj roka sjetve i /ili načina suzbijanja korova na težinu suhe tvari i učinkovitost suzbijanja korova prema određenim danima nakon sjetve soje*

| Treatments | Weed dry matter (g $m^{-2}$) at | | | Weed control efficiency (%) at | |
|---|---|---|---|---|---|
| | 20 DAS | 40 DAS | 60 DAS | 40 DAS | 60 DAS |
| **Sowing date** | | | | | |
| $S_1$ | 1.90 | 9.07 c | 13.88 b | 59.42 b | 63.23 |
| $S_2$ | 1.91 | 7.52 d | 10.58 c | 61.65 ab | 63.30 |
| $S_3$ | 1.94 | 10.39 b | 14.48 ab | 62.04 a | 61.70 |
| $S_4$ | 1.96 | 11.86 a | 15.62 a | 60.02 ab | 62.18 |
| $LSD_{(0.05)}$ | 0.283 | 1.064 | 1.499 | 2.432 | 2.202 |
| **Weed control methods** | | | | | |
| $W_0$ | 1.97 | 24.76 a | 36.42 a | 0 | 0 |
| $W_1$ | 1.87 | 3.42 d | 4.12 d | 86.25 a | 88.97 a |
| $W_2$ | 1.96 | 6.32 b | 7.99 b | 74.62 c | 77.67 c |
| $W_3$ | 1.91 | 4.35 c | 6.03 c | 82.26 b | 83.77 b |
| $LSD_{(0.05)}$ | 0.212 | 0.706 | 0.806 | 2.320 | 1.958 |
| **Sowing date × Weed control methods** | | | | | |
| $S_1W_0$ | 1.93 | 22.32 c | 37.70 b | 0 | 0 |
| $S_1W_1$ | 1.88 | 3.47 hi | 3.47 hi | 84.66 ab | 90.88 a |
| $S_1W_2$ | 1.90 | 6.07 f | 7.40 def | 72.95 ef | 80.39 cd |
| $S_1W_3$ | 1.87 | 4.43 gh | 6.93 def | 80.07 b-d | 81.64 cd |
| $S_2W_0$ | 1.90 | 19.63 d | 28.87 c | 0 | 0 |
| $S_2W_1$ | 1.87 | 2.47 i | 2.23 i | 87.46 a | 92.39 a |
| $S_2W_2$ | 1.97 | 4.57 f-h | 7.90 de | 76.60 de | 72.54 e |
| $S_2W_3$ | 1.90 | 3.40 hi | 3.33 hi | 82.55 a-c | 88.25 ab |
| $S_3W_0$ | 2.02 | 27.37 b | 37.80 b | 0 | 0 |
| $S_3W_1$ | 1.90 | 3.53 hi | 6.33 ef | 87.11 a | 83.34 c |
| $S_3W_2$ | 1.93 | 5.93 fg | 7.67 de | 78.32 cd | 78.90 d |
| $S_3W_3$ | 1.89 | 4.73 f-h | 5.83 fg | 82.73 a-c | 84.56 bc |
| $S_4W_0$ | 2.02 | 29.70 a | 41.30 a | 0 | 0 |
| $S_4W_1$ | 1.82 | 4.22 h | 4.43 gh | 85.76 a | 89.25 a |
| $S_4W_2$ | 2.02 | 8.70 e | 8.73 d | 70.63 f | 78.83 d |
| $S_4W_3$ | 1.98 | 4.83 f-h | 8.00 de | 83.69 ab | 80.62 cd |
| $LSD_{(0.05)}$ | 0.423 | 1.412 | 1.612 | 4.641 | 3.915 |

Values followed by different letters within the same column are significantly different at 0.05 probability level; $S_1$=18th December, $S_2$=2nd January, $S_3$=17th January, $S_4$=1st February, $W_0$=No weeding, $W_1$= Hand weeding at 20 and 40 DAS, $W_2$= Hand hoe weeding at 20 and 40 DAS, $W_3$= Whip Super 9 EC (Fenoxaprop-P-ethyl)

**Weed control efficiency (%)**

Weed control efficiency was significantly affected by different sowing date at 40 DAS and showed non-significant effect at 60 DAS (Table 3). The highest weed control efficiency was achieved from 17th January which was statistically at par with 2nd January and 1st February. The lowest was observed from 18th December which was statistically similar with 1st February and 2nd January sowing. Weed control method had also significant effect on weed control efficiency of soybean at 40 and 60 DAS. Hand weeding at 20 and 40 DAS showed the best result at 40 and 60 DAS. At 40 DAS, weed control efficiency of hand weeding at 20 and 40 DAS was 86.25% whereas it increased to 88.97% at 60 DAS. The lowest weed control efficiency (74.62 and 77.67%, respectively) was shown by hand hoe weeding at 20 and 40 DAS at 40 and 60 DAS. Rajput and Kushwah (2004) observed that two hand weeding alone 20 and 30 DAS after sowing obtained in highest weed control efficiency 85.6%. Due to the combined effect of sowing date and weed control method, weed control efficiency of soybean was significantly affected at different date after sowing (Table 3). The best weed control efficiency (87.46, 92.39%) was achieved from combination of 2nd January with hand weeding at 20 and 40 DAS which was statistically similar to 1st February with hand weeding at 20 and 40 DAS, 18th December with hand weeding at 20 and 40 DAS. The lowest (70.63, 72.54%) was from sowing at 1st February and 2nd January with hand hoe weeding at 20 and 40 DAS which was statistically similar to sowing seeds on 18th December with hand hoe weeding at 20 and 40 DAS.

**Plant height (cm)**

The significant result was found out in plant height of soybean by the sowing date at different growth stages (Table 4). Plant height decreased significantly with delay in planting. Reduced plant height with delay in planting might be due to quick changes in photoperiod, which accelerated development towards reproductive stages and hence less time was available for vegetative growth. The greater plant height recorded in 30th December was probably due to comparatively longer growing period along with the optimum environmental conditions. These results were in line with those reported by Wade and Johnston (1975) who stated that photoperiod sensitivity marking reduction in growth period due to delayed seeding might account for decrease in plant height. Other researchers have also found out that plant height generally decreased with delayed planting by Zynali et al. (2003); Hamzeh et al. (2004). Weed control method had significant effect on plant height of soybean at 20, 60, 80 DAS and at harvest stage and non-significant effect at 40 DAS (Table 4). The plant height showed an increasing trend with increasing the age of plant up to 80 DAS for all weed control method. The rate of increase was found out slow up to 40 DAS after that plant height increased sharply up to 80 DAS. From 80 DAS, the height was reduced slightly and continued up to at harvest irrespective of all weed control method. Combination effect between sowing date and weed control method on plant height of soybean was significantly affected at different growth stages (Table 4). Early sowing (2nd January) with weeding at 20 and 40 DAS produced the tallest plant height which was statistically similar with treatment combination of 2nd January with Whip Super 9 EC whereas, late sowing (1st February) with no weeding showed the shortest plant height.

**Table 4. Combination effect of sowing date and/or weed control method on plant height of soybean at different DAS**

*Tablica 4. Utjecaj kombinacije roka sjetve i/ili načina suzbijanja korova na visinu biljke soje u određenim danima nakon sjetve*

| Treatments | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | 20 DAS | 40 DAS | 60 DAS | 80 DAS | At harvest |
| **Sowing date** | | | | | |
| $S_1$ | 8.58 b | 18.99 b | 39.80 b | 59.07 a | 45.41 ab |
| $S_2$ | 9.91 a | 24.99 a | 50.69 a | 59.18 a | 48.74 a |
| $S_3$ | 7.53 c | 16.29 c | 32.95 c | 51.21 b | 45.83 ab |
| $S_4$ | 7.38 c | 16.26 c | 27.94 d | 44.95 c | 43.53 b |
| $LSD_{(0.05)}$ | 0.86 | 2.16 | 4.88 | 7.58 | 3.32 |
| **Weed control method** | | | | | |
| $W_0$ | 7.98 b | 18.51 | 35.81 b | 50.01 b | 43.23 b |
| $W_1$ | 8.45 ab | 19.77 | 40.39 a | 56.15 a | 48.57 a |
| $W_2$ | 8.20 ab | 19.04 | 36.78 ab | 53.16 ab | 44.61 ab |
| $W_3$ | 8.76 a | 19.21 | 38.41 ab | 55.09 a | 47.09 ab |
| $LSD_{(0.05)}$ | 0.59 | 1.47 | 3.44 | 4.61 | 4.26 |
| **Sowing date × Weed control method** | | | | | |
| $S_1W_0$ | 8.37 c-f | 18.27 b-d | 37.54 c-e | 55.47 a-c | 41.27 ab |
| $S_1W_1$ | 8.67 b-d | 19.32 b | 43.66 bc | 61.98 a | 48.29 ab |

| Treatments | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | 20 DAS | 40 DAS | 60 DAS | 80 DAS | At harvest |
| $S_1W_2$ | 8.60 b-d | 19.15 bc | 38.91 cd | 57.17 ab | 44.29 ab |
| $S_1W_3$ | 8.67 b-d | 19.22 bc | 39.10 cd | 61.67 a | 47.78 ab |
| $S_2W_0$ | 9.63 a-c | 24.37 a | 47.00 ab | 57.77 ab | 47.00 ab |
| $S_2W_1$ | 10.05 a | 26.15 a | 53.50 a | 60.35 a | 50.58 a |
| $S_2W_2$ | 9.83 ab | 24.65 a | 50.11 ab | 58.92 a | 47.39 ab |
| $S_2W_3$ | 10.13 a | 24.78 a | 52.16 a | 59.67 a | 50.00 ab |
| $S_3W_0$ | 6.83 g | 15.83 cd | 32.92 d-g | 45.78 c-e | 44.73 ab |
| $S_3W_1$ | 7.60 d-g | 16.53 b-d | 34.14 d-f | 54.14 a-d | 48.34 ab |
| $S_3W_2$ | 7.20 e-g | 16.25 b-d | 31.06 e-g | 52.36 a-d | 44.82 ab |
| $S_3W_3$ | 8.50 c-e | 16.53 b-d | 33.69 d-f | 52.55 a-d | 45.43 ab |
| $S_4W_0$ | 7.10 fg | 15.57 d | 25.78 g | 41.02 e | 39.93 b |
| $S_4W_1$ | 7.50 d-g | 17.07 b-d | 30.26 e-g | 48.14 b-e | 47.08 ab |
| $S_4W_2$ | 7.17 e-g | 16.11 b-d | 27.02 fg | 44.17 de | 41.94 ab |
| $S_4W_3$ | 7.73 d-g | 16.29 b-d | 28.69 fg | 46.48 c-e | 45.15 ab |
| $LSD_{(0.05)}$ | 1.18 | 2.94 | 6.89 | 9.20 | 8.52 |

Values followed by different letters within the same column are significantly different at 0.05 probability level; $S_1$=18th December, $S_2$=2nd January, $S_3$=17th January, $S_4$=1st February, $W_0$=No weeding, $W_1$= Hand weeding at 20 and 40 DAS, $W_2$= Hand hoe weeding at 20 and 40 DAS, $W_3$= Whip Super 9 EC (Fenoxaprop-P-ethyl)

### Dry weight plant$^{-1}$ (g)

Sowing date had significant effect on dry weight plant$^{-1}$ of soybean at 20, 40 and 60 DAS and non-significant effect at 80 DAS and at harvest (Table 5). Dry weight plant$^{-1}$ showed an increasing trend with advances of time for all sowing dates. The rate of increase was found slow up to 40 DAS after dry weight increased sharply up to harvest irrespective of sowing dates. Late plant takes 13-25 day short time for their completion of life period in comparison with early planting date causing the collection of dry material and active photosynthesis radiations to be decreased (Purcell et al., 2002). In the end of the growth season whose unsuitable condition of temperature prevents the production of enough assimilate dry material plays an important role in increasing weight of grain (Fanaie et al., 2008). Similar results were found by Rondanini et al. (2006). Weed control method showed significant effect on dry weight plant$^{-1}$ of soybean at different date after sowing (Table 5). Dry weight plant$^{-1}$ showed an increasing trend with advancement of growth stages of plant for all weed control method. The rate of increase was found slower up to 40 DAS, after dry weight increased steadily up to harvest irrespective of all weed control methods. Van Acker et al. (1993) stated that weed interference caused a significant decrease in soybean total aboveground dry weight. Combination of sowing date and weed control method had significant effect on dry weight plant$^{-1}$ of soybean at 20, 40, 60 DAS, 80 DAS and harvest (Table 5). The maximum amount of dry weight plant$^{-1}$ was accumulated from treatment combination of 2nd January with hand weeding at 20 and 40 DAS being statistically similar to 2nd January with Whip Super 9 EC while, the lowest was obtained from late sowing at 1st February with no weeding treatment.

**Table 5. Combination effect of sowing date and/or weed control method on dry weight plant$^{-1}$ and seed yield of soybean**

*Tablica 5. Učinak kombinacije roka sjetve i/ili načina suzbijanja korova na težinu suhe tvari i prinos sjemena soje*

| Treatments | Dry weight plant$^{-1}$ (g) at | | | | | Seed yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|
| | 20 DAS | 40 DAS | 60 DAS | 80 DAS | At harvest | |
| **Sowing date** | | | | | | |
| $S_1$ | 0.68 a | 1.46 b | 7.38 ab | 20.71 | 31.44 | 1.99 ab |
| $S_2$ | 0.69 a | 2.70 a | 7.82 a | 20.95 | 32.53 | 2.17 a |
| $S_3$ | 0.60 b | 1.35 b | 6.06 bc | 20.08 | 29.18 | 1.91 b |
| $S_4$ | 0.47 c | 1.19 b | 5.59 c | 19.40 | 27.81 | 1.64 c |
| $LSD_{(0.05)}$ | 0.13 | 0.22 | 1.43 | 3.42 | 4.35 | 0.23 |
| **Weed control method** | | | | | | |
| $W_0$ | 0.55 c | 1.47 b | 5.99 | 16.87 b | 27.16 b | 1.39 c |
| $W_1$ | 0.67 a | 1.97 a | 7.46 | 22.76 a | 35.75 a | 2.23 a |
| $W_2$ | 0.60 bc | 1.58 b | 6.52 | 20.14 ab | 28.14 b | 1.89 b |

| Treatments | Dry weight plant$^{-1}$ (g) at | | | | | Seed yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|
| | 20 DAS | 40 DAS | 60 DAS | 80 DAS | At harvest | |
| $W_3$ | 0.64 ab | 1.69 ab | 6.88 | 21.37 a | 29.91 b | 2.19 a |
| $LSD_{(0.05)}$ | 0.07 | 0.14 | 1.09 | 2.25 | 2.89 | 0.13 |
| **Sowing date × Weed control method** | | | | | | |
| $S_1W_0$ | 0.57 b-f | 1.29 bc | 5.50 b | 17.30 | 28.73 b | 1.29 h |
| $S_1W_1$ | 0.79 a | 1.80 b | 9.01 a | 22.04 | 34.06 ab | 2.37 ab |
| $S_1W_2$ | 0.65 a-d | 1.35 bc | 7.21 ab | 21.50 | 30.99 b | 1.97 d-f |
| $S_1W_3$ | 0.72 ab | 1.41 bc | 7.82 ab | 22.00 | 31.98 ab | 2.32 a-c |
| $S_2W_0$ | 0.62 b-e | 2.45 a | 7.74 ab | 17.53 | 29.09 b | 1.73 fg |
| $S_2W_1$ | 0.72 ab | 2.87 a | 7.74 ab | 24.25 | 41.80 a | 2.50 a |
| $S_2W_2$ | 0.71 ab | 2.66 a | 7.76 ab | 20.37 | 29.49 b | 2.05 c-e |
| $S_2W_3$ | 0.71 ab | 2.80 a | 7.88 ab | 21.66 | 29.76 b | 2.39 ab |
| $S_3W_0$ | 0.53 c-f | 1.11 c | 5.66 b | 15.90 | 26.94 b | 1.34 h |
| $S_3W_1$ | 0.68 a-c | 1.86 b | 6.50 ab | 23.00 | 33.28 ab | 2.19 b-d |
| $S_3W_2$ | 0.56 b-f | 1.19 bc | 6.04 ab | 20.57 | 28.22 b | 1.92 d-f |
| $S_3W_3$ | 0.65 a-d | 1.26 bc | 6.05 ab | 20.83 | 28.28 b | 2.20 b-d |
| $S_4W_0$ | 0.45 f | 1.03 c | 5.06 b | 16.76 | 23.87 b | 1.20 h |
| $S_4W_1$ | 0.51 d-f | 1.34 bc | 6.42 ab | 21.74 | 33.86 ab | 1.86 e-g |
| $S_4W_2$ | 0.47 ef | 1.11 c | 5.08 b | 18.12 | 23.87 b | 1.63 g |
| $S_4W_3$ | 0.47 ef | 1.28 bc | 5.78 ab | 20.99 | 29.63 b | 1.85 e-g |
| $LSD_{(0.05)}$ | 0.14 | 0.28 | 2.18 | 4.49 | 5.79 | 0.26 |

Values followed by different letters within the same column are significantly different at 0.05 probability level; $S_1$=18$^{th}$ December, $S_2$=2$^{nd}$ January, $S_3$=17$^{th}$ January, $S_4$=1$^{st}$ February, $W_0$=No weeding, $W_1$= Hand weeding at 20 and 40 DAS, $W_2$= Hand hoe weeding at 20 and 40 DAS, $W_3$= Whip Super 9 EC (Fenoxaprop-P-ethyl)

**Seed yield (t ha$^{-1}$)**

Sowing date had significant effect on seed yield of soybean (Table 5). The maximum seed yield was obtained from sowing date 2$^{nd}$ January and the lowest was found out from 1$^{st}$ February. In late planting, due to the loss of suitable time for the growth, the plant was not achieved its potential ability because light interception and crop simulates partitioning were severely affected and consequently led to yield decline. In case of early planting there was more time for plant growth and development, so seed yield increased was rational. Similar results were recorded with late planting by Calvino et al. (2003); Ahmed et al. (2010); Ngalamu et al. (2012). Weed control method exerted significant effect on seed yield of soybean (Table 5). The highest seed yield was observed from hand weeding at 20 and 40 DAS and the lowest was found out from no weeding treatment. The enhancement in the seed yield due to various weed control measures was because of the fact that they helped to keep the field comparatively free from weeds, thus resulting in better utilization of resources namely, nutrients, moisture, solar light etc. These consequently led to the production of more vigorous and healthy plants having more pod bearing capacity, more seed per pod and 100-seed weight. The cumulative effect of all these resulted in higher seed yields. The results corroborate the findings of Vyas et al. (2000); Pandya et al. (2005) who reported enhanced soybean yield due to various weed control treatments. Combination of sowing date and weed control method had significant effect on seed yield of soybean (Table 5). The highest seed yield (2.50 t ha$^{-1}$) was observed from sowing at 2$^{nd}$ January with hand weeding at 20 and 40 DAS whereas, the lowest (1.20 t ha$^{-1}$) was obtained from combination of 1$^{st}$ February sowing with no weeding treatment. Nepomuceno et al. (2007) evaluated weed interference in soybean in conventional sowing system and reported a 32% drop in the yield of the crop when it coexisted with weeds throughout their cycle, which agrees with this experiment.

## CONCLUSION

Different sowing date and weed control methods played a vital role for the growth and yield of soybean. Early planting favored the growth and yield of soybean. On the other hand, hand weeding at 20 and 40 DAS was the best weed control practice. So, on the basis of above mentioned discussion, 2$^{nd}$ January and hand weeding (20 and 40 DAS) showed better performance compared to those of other treatments. However, application of Whip Super 9 EC (Fenoxaprop-P-ethyl) also will be a promising practice for controlling weed in soybean field.

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# UTJECAJ ROKA SJETVE I NAČINA SUZBIJANJA KOROVA NA RAST I PRINOS SOJE

**SAŽETAK**

***Rok sjetve i suzbijanje korova imaju značajan utjecaj na rast i razvoj soje te formiranje prinosa sjemena. Rezultati su pokazali značajan utjecaj različitih rokova sjetve i načina suzbijanja korova na relativnu gustoću korova, biomasu korova, učinkovitost suzbijanja korova, visinu biljke, suhu masu biljke i prinos sjemena soje. Od korovnih vrsta u pokusnoj su parceli bili dominantni Lindernia procumbens (44.78%), Echinochloa colonum (26.39 %) i Cynodon dactylon (16.30 %). Rezultati su, također, pokazali da je najveći prinos sjemena (2,17 t ha$^{-1}$) postignut u ranoj sjetvi (2. siječnja), a najniži prinos (1,64 t ha$^{-1}$) u kasnoj sjetvi (1. veljače). Dva puta ručno uklanjanje korova (20 i 40 dana nakon sjetve) najučinkovitije je suzbilo korov i postiglo najveći prinos sjemena (2,23 t ha$^{-1}$), što je statistički sukladno (2,19 t ha$^{-1}$) s primjenom herbicida. Učinak kombinacije pokazao je najveći prinos zrna (2,50 t ha$^{-1}$), koji je utvrđen kod roka sjetve 2. siječnja, kada je korov ručno uklanjan 20 i 40 dana nakon sjetve.***

***Ključne riječi: relativna gustoća korova, soja, rok sjetve, učinkovitost uklanjanja korova, korovne vrste***

(Received on 7 January 2016; accepted on 26 May 2016 – *Primljeno 7. siječnja 2016.; prihvaćeno 26. travnja 2016.*)