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YIELD AND TUBER QUALITATIVE CHARACTERISTICS OF LOCAL POTATO CULTIVAR POLURANKA

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SUMMARY

Trials with potato cultivar Poluranka were conducted in Bosnia and Herzegovina. Tuber dry matter, N and NO_3-N content were detected in different growth phases. Complete randomized block design in three replications with four nitrogen treatments (50, 100, 150 and 200 kg N ha^{-1}) and control (0 kg N ha^{-1}) were used. Duration of vegetation period of *Poluranka* was 125 days. Tubers were sampled on 110th day and 125th day after planting (DAP). Samples were dried in dry oven on 105°C for 5 to 6 hours for dry matter analysis. Total N content was determinate in relation to tuber total dry matter (%). Concentration of NO_3-N was analyzed in tuber sap. Tubers from five plants per replications were collected, weighted and calculated as t ha^{-1} yield. Optimal dry matter content in limits of 18.46 to 23.03 % has no significant difference under higher input of nitrogen. Considering nitrogen fertilization treatments and two sampling periods higher dry matter content was found in control treatment and generally at first sampling. Tuber N content was 1.12% to 1.77% and showed no significant differences regarding fertilization treatments and sampling time. Content of NO_3-N in tuber sap was significant with sampling time but the differences in fertilization treatment were not so high to show differences in tuber NO_3-N content. Yield was significantly influenced by fertilization with increasing N doses and sampling time, with range of 12.72 t ha^{-1} to 31.07 t ha^{-1}. So far there were no research carried out in relation to the measurement of mentioned parameters of *Poluranka* varieties with respect to the application of different N fertilization and time of sampling. Since *Poluranka* is local autochthonous cultivar adapted to highland area of Herzegovina and maintained by people in the area, same qualitative characteristics can be comparable to modern cultivar, but biotic and abiotic factors influenced on yield performance.

Key words: potato, autochthonous variety, dry matter, N, NO_3-N, yield

INTRODUCTION

Poluranka is local Herzegovinian potato varieties dominate in the production in highland area of Herzegovina. Introduction of modern high productive varieties supplanted this variety from the production. Its growing today is at a neglected level and it is endangered to completely disappear from its habitat. Although this variety is characterized by very good quality reaction on different N fertilization management. The yield and quality of potatoes (*Solanum tuberosum* L) are strongly affected by fertilization level. Proper N fertilization is critical for optimizing potato yield and quality (Westermann and Kleinkopf, 1985). Today more problems are related in over-N fertilization rates which can result in reduced yields (Lauer, 1986) and reduced tuber dry matter content (Porter and Sisson, 1991) especially in late-maturity varieties. The portion of the applied N partly remains in the vines, while most of the N taken up by the crop is removed in the harvested tubers. Relatively high pre-plant N applications can delay potato *(Solanum tuberosum* L.) tuber growth 7 to 10 days, particularly for late-maturity potato varieties (Kieinkopf et al, 1981). Tuber dry matter production rates also vary with variety and season (Kunkel et al., 1973). Haase et al. (2007) reported that N fertilizer increased plant dry weight and N content of tissues as well as N absorption in the tubers. Jamaati-e-Somarin el al. (2009) reported the increase in nitrate contamination of the tuber fresh and dry weight following the increase in applied N fertilizer. They have also concluded that different levels of applied N affect tuber yield, N absorption level and N use efficiency. Inappropriate rates of nitrogen causes accumulation of this element highly in crops which usually don't accumulate it (Saeidi et al., 2009). Beljo et al. (2006) founded that in the same growing conditions *Poluranka* variety has 30 to 40 % lower yield then modern cultivar usually grown on Herzegovina region but it has 10 to 20% higher tuber dry matter content. Autochthonous (indigenous) potato varieties are popular because of good taste but low yielding and high price and on the other hand modern varieties are high yielding. Beside low genetically potential for yield quality autochthones potatoes are very much susceptible to the viral diseases. The yield reduction may be up to 75 % caused by the infection of some viruses. This paper is primarily focused on reaction of *Poluranka* variety in dry mater production, nitrogen and nitrate tuber accumulation and yield production regarding a different sampling time and nitrogen supply.

MATERIALS AND METHODS

Potatoes field were set up on mountainous area of Šćitar in 2009 on altitude of 1404 m located in Posušje municipality. A basic soil test was provided to make applications with NPK 7:20:30 fertilizer at pre planting and additional dressing with UREE and KAN. Fertilization with phosphorus and potassium was determined on the basis of soil analysis. Standard doses of P_2O_5 (140 kg ha^{-1}) and K_2O (210 kg ha^{-1}) were

applied at pre-planting period. Five different N rates were applied 0, 50, 100, 150 and 200 kg N ha^{-1}. Nitrogen fertilization of crops toward the target volume was obtained by applying ½ of the total amount of nitrogen at pre-planting and ½ before hilling, 45 days after the planting. The usual crop management was used for weed, pest and disease control. Random block design with three replications was used. Local *Poluranka* tubers were used for manual planting with in-rows seed space 0.70m and between rows 0.20m. Tubers planting were on May 03rd and harvesting was on September 12th. Experimental design was set up on 300 m^2 surface. Duration of vegetation period of *Poluranka* was 125 days. Tubers were sampled on 110th day and 125th day after planting (DAP). Tuber dry matter (%), N content (%), NO_3-N concentration (mg kg^{-1} fresh weight) and tuber yield (t ha^{-1}) of *Poluranka* variety were detected. Potato tuber samples were carried to the laboratory, oven-dried at 105°C for 5 to 6h (for tuber dry matter content), weighed, homogenized and stored for chemical analyses. Total nitrogen concentration of potato tuber was analyzed by Kjeldahl method (AOAC, 1970). NO_3-N concentration was measured in fresh tuber sap. Potato tissue samples were pressured by a garlic press and sap was immediately taken for NO_3-N determination by Cardy ion meter. Fresh tuber yield in physiology (110 DAP) and technology phase (125 DAP) was calculated by harvesting five plants from middle rows of each plot. Agronomic properties of this variety were also compared to modern most grown varieties provide by other research. Obtained values were analyzed by ANOVA for find the differences in tuber dry matter, N, NO_3-N and yield of cultivar *Poluranka* fertilized with increasing N rates in two growth periods 110 and 125 day after the planting. For statistical processing the data GenStat 7 software (Laws Agricultural Trust, Rothamsted Experimental Station) were used.

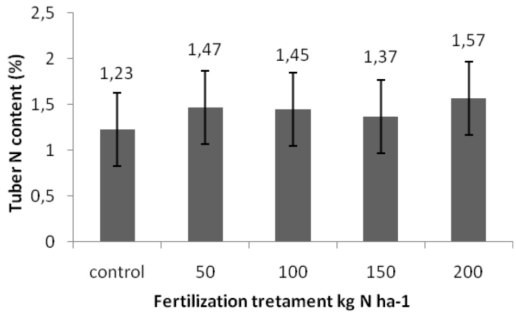
RESULTS AND DISCUSSION

Slight increments in tuber N values from control to the highest fertilization were shown on Figure 1, but the differences between treatments were not significant. Lowest N tuber content was measured in control (1.23% N) and highest (1.57% N) by fertilization of 200 kg N ha^{-1}. Tuber dry matter was not significantly different regarding the fertilization treatments but the highest average value (21.89 %) was obtained in control and variant with lower N input (Figure 2). Similar N and dry matter values were obtained in first and second sampling. According to the Shahbazi et al., (2009) higher tuber dry weight was observed in control treatment. Same increments of dry matter in control treatment happened in tuber of *Poluranka* but decrement of values were followed by application of higher N input. Non-significant difference in dry matter of

tubers due to applied N treatment was not only in *Poluranka*, but Roberts and Cheng (1988) reported the same in some modern cultivars. Majić et al., (2007) have reported in two years potatoes trials tuber N content of modern cultivars varying from the 1.1 to 1.5% for the first and 1.20 to 3.16% of N for second year with N input varying from 0 to 300 kg N ha^{-1}. Authors have reported the tuber dry weight 22.16% in control decreasing to the 20.12 % in highest fertilization for the first year while in the second year the same dry matter content was in control but lower (19.41%) in highest fertilization. Furthermore, lower tuber N content have shown higher dry matter in each fertilization for first year while in second year higher tuber N content shows lower dry matter. For first sampling of tubers of *Poluranka* results shows that the higher dry matter content results in lower N tuber while inversely happened for second sampling. Santamaria et al. (1999) stated that the reduction in dry matter content by increasing nitrogen fertilization can be attributed to the replacement of organic acids and sugars by nitrate.

Figure 1 Average tuber N content obtained in different fertilization treatment. Bars shows the least significant differences in tuber N content between fertilization treatment comparing with $LSD_{0.05}$=0.40

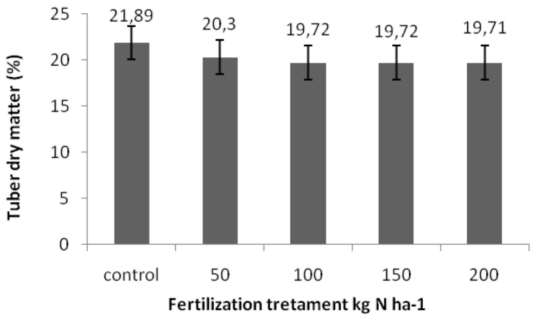
Grafikon 1. Srednje vrijednosti sadržaja N u gomolju kultivara dobiveni kod različitih gnojidbenih tretmana. Crte pokazuju najmanju signifikantnu razliku u sadržaju N između gnojidbenih tretmana kompariranih s $LSD_{0.05}$=0,40



NO_3-N concentrations in fresh tuber sap were affected by sampling periods showing the significantly lower values of 62.1 mg kg^{-1} NO_3-N for 110 DAP from the values obtained 125 DAP of 83.9 mg kg^{-1} NO_3-N. Increase in nitrate may be due to the redistribution of nutrients from the aboveground parts of crops in to the tuber tissue. At harvest time around 40% of total accumulated N tuber amount originate from

Figure 2 Average tuber dry matter content obtained in different fertilization treatment. Bars shows the least significant differences in tuber dry matter content between fertilization treatment in comparison to $LSD_{0.05}$=1,82

Grafikon 2. Srednje vrijednosti sadržaja suhe tvari u gomolju kultivara dobiveni kod različitih gnojidbenih tretmana. Crte pokazuju najmanju signifikantnu razliku u sadržaju suhe tvari između gnojidbenih tretmana kompariranih s $LSD_{0.05}$=1,82



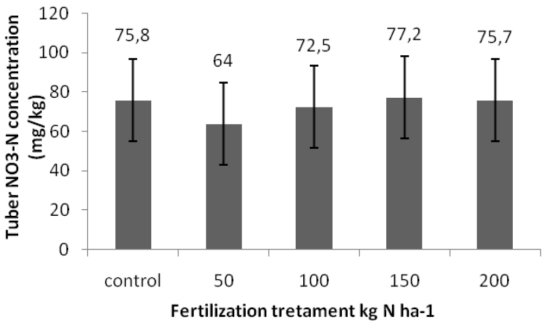
remobilization from the leaves (34%) and stems (6%), while the remaining 60% was adopted from the soil and directly transported to the tuber (Millard and MacKerron, 1986).

According to this nitrate higher tuber accumulation within 15 days from the first sampling also could be due to the environmental conditions occurred in September and without any response to nitrogen nutrition. Tuber NO_3-N values were not significantly different regarding the fertilization treatments but the highest values were obtained in fertilization with 150 kg N ha^{-1} (Figure 3). In some cases different nitrate content in tubers depends on agro-ecological factors (tillage, fertilization, irrigation) and climate during the vegetation period (Cieslik, 1995).

No significant interaction between sampling period and fertilization treatment for tuber NO_3-N concentration has occurred. According to the Shahbazi et al., (2009) the higher nitrate accumulation in fresh tuber weight was observed in early-mature variety at highest N application (145.9 mg kg^{-1} in cv. *Satina*). Late-mature variety produced the higher tuber yield but the lowest nitrate accumulation and higher N input increase nitrate concentration in tuber tissue (Shahbazi et al., 2009). Jamaati-e-Somarin et al. (2009) reported the highest nitrate contamination was observed in the highest fertilizer level (200 kg N ha^{-1})

Figure 3 Average tubers NO_3-N concentration obtained in different fertilization treatment. Bars shows the least significant differences in tuber NO_3-N concentration between fertilization treatment in comparison to $LSD_{0.05}$=20,85

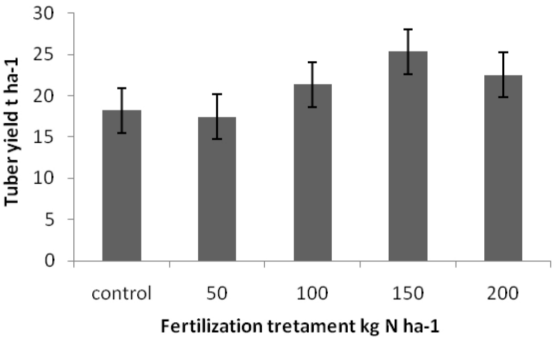
Grafikon 3. Srednje vrijednosti sadržaja NO_3-N u gomolju kultivara dobiveni kod različitih gnojidbenih tretmana. Crte pokazuju najmanju signifikantnu razliku u sadržaju NO_3-N između gnojidbenih tretmana kompariranih s $LSD_{0.05}$=20,85



Significant higher (P=0.05) yield of 26.40 t ha^{-1} was obtained by sampling in technological phase on 125 DAP; while 15.53 t ha^{-1} was obtained in physiological phase on 110 DAP (Figure 5). Significant differences (P=0.05) in yield were noticed due to the different fertilization treatment. The highest yield of 25.34 t ha^{-1} was obtained in fertilization with 150 kg N ha^{-1} but there were no significant differences in yield fertilized with 100 and 200 kg N ha^{-1} (Figure 4). Significant lower yield was obtained in

Figure 4 Average tuber yield of *Poluranka* obtained in different fertilization treatment. Bars shows the least significant differences in yield between fertilization treatment in comparison to $LSD_{0.05}$=2.72

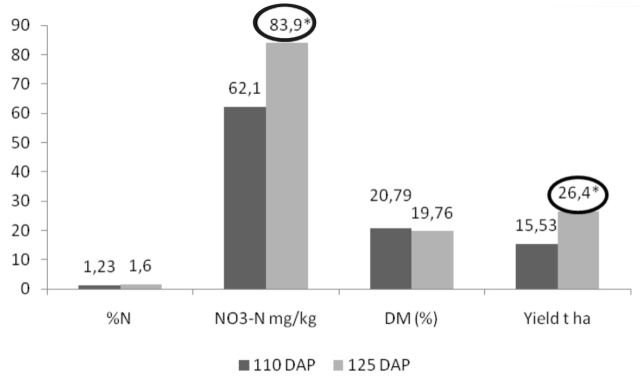
Grafikon 4. Srednje vrijednosti prinosa gomolja kultivara Poluranka dobiveni kod različitih gnojidbenih tretmana. Crte pokazuju najmanju signifikantnu razliku u prinosu između gnojidbenih tretmana kompariranih s $LSD_{0.05}$=2.72



control and with fertilization of 50 kg N ha^{-1} but comparing to the fertilization 100 and 200 kg N ha^{-1} there were no significant differences.

Figure 5 Measured parameters (%N, NO_3-N mg kg^{-1}, % DM, yield t ha^{-1}) on *Poluranka* variety obtained 110 and 125 DAP

Grafikon 5. Parametri (%N, NO_3-N mg kg^{-1}, % DM, yield t ha^{-1}) mjereni na kultivaru Poluranka 110. i 125. dan nakon sadnje



Poluranka showed the highest yield and nitrate accumulation after application of 150 kg N ha^{-1} without significant differences in concentration between N applications. Highest NO_3-N concentration in tuber after application of 150 kg N ha^{-1} was not followed by highest values of tuber N content. According to Majić et al. (2007a) increment of tuber NO_3-N concentration was followed by increscent of yield in modern cultivars. Jamaati-e-Somarin el al. (2009); Shahbazi et al., (2009) have reported that the highest tuber yield and number, dry weight and mean tuber weight were reached by nitrogen application of 160 kg N ha^{-1} while at the higher level (more than 160 kg N ha^{-1}) decrease of mentioned parameters were observed. In our research autochthonous potato cultivar *Poluranka* has showed same reaction in yield on nitrogen application where higher yield was obtained by applying 150 kg N ha^{-1} rather than 200 kg N ha^{-1}. The main difference was that the yield obtained by modern cultivar in research provided by Jamaati-e-Somarin el al. (2009), Shahbazi et al., (2009) was 20-30% higher comparing to yield of *Poluranka*. According to Beljo et al., (2006) in two year field trial *Poluranka* have obtained average yield 13.45 t ha^{-1} in standard growing condition in lowland region of Herzegovina but they were 2 to 3 time lower than two years average of modern cultivar yield (35.48 t ha^{-1} Jerla, 34.14 t ha^{-1} Adora, 39.64 t ha^{-1} Liseta, Amorosa 37.50 t ha^{-1}). Comparing to the yield achieved in our trial we can see it is little bit higher due to the applied N rate. Not only the nutrient application dictate yield it is also environment conditions who can make large impact on targeted yield. In

same field trial Beljo et al., (2006) showed data about *Poluranka* tuber dry matter with two years average of 24.86% while modern cultivars had lower tuber dry matter content (21.21 % Jerla, 20.77 % Adora, 21.94 % Liseta, Amorosa 19.46%) and we had reached tuber dry matter of 21.89 %. As the *Poluranka* has genetic predisposition for higher dry matter content in tuber Beljo et al., (2006) have suggested this cultivar as valuable breeding material. Collection and preservation of the plant breeding materials is one of the main terms for maintaining genetic diversity of plants, due to the future agriculture prosperity (Beljo et al., 2006).

CONCLUSION

Application of 150 kg N ha^{-1} showed highest tuber yield of *Poluranka* in 25.34 t ha^{-1} while further increment of nitrogen fertilization rate have not result in significant higher yield. Nitrogen and tuber dry matter weren't significantly affected by different sampling period or fertilization treatment. Control showed highest tuber dry matter of 22.16% and lowest N content 1.23%. As tuber yield, the NO_3-N resulted in highest concentrations by application of 150 kg N ha^{-1} and the concentration was higher in second sampling period. Trials with *Poluranka* variety should be continued in order to obtain more accurate dates for measured parameters. The yield of *Poluranka* cultivar was low and the tuber dry matter was appreciable by recommendations of other author's this makes the cultivar valuable breeding material.

PRINOS I KVALITATIVNE ZNAČAJKE GOMOLJA AUTOHTONOG KULTIVARA KRUMPIRA POLURANKA

SAŽETAK

Istraživanje koje je provedeno na lokalnoj autohtonoj sorti krumpira Poluranka u Federaciji BiH odnosi se na analizu suhe tvari u gomolju u vrijeme fiziološke i tehnološke zrelosti, te utvrđivanje koncentracije N i NO_3-N uslijed primjene gnojidbe s različitim dozama N gnojiva. Pokus je postavljen na brdsko planinskom području općine Posušje na nadmorskoj visini 1404 m. Korišten je slučajni blokni raspored s četiri razine gnojidbe (N 50, 100, 150 i 200 kg N ha^{-1}) i kontrolom (bez gnojidbe) u tri repeticije. Vegetacija je trajala 125 dana. Gomolji ovog autohtonog kultivara su uzeti 110. dan nakon sadnje i na kraju vegetacije 125. dan. Sadržaj suhe tvari određen je sušenjem uzorka u sušioniku na 105°C oko 5 do 6 sati. Uzorci N određeni su na suhu tvar (%) biljnog materijala, a sadržaj NO_3-N utvrđen je u svježem soku gomolja. Prinos sorte je određen sakupljanjem gomolja s pet biljaka po varijanti, nakon čega su vrijednosti preračunate na t ha^{-1}. Statističkom analizom utvrđeno je da je sadržaj suhe

tvari izrazito povoljan, odnosno kreće se u optimalnim granicama 18,46 do 23,03 %, te se primjena rastućih doza N nije signifikantno odrazila na sadržaj suhe tvari. Iako razlike između vrijednosti s obzirom na primijenjenu gnojidbu i period uzorkovanja nisu značajne, veći sadržaj suhe tvari utvrđen je u kontrolnom tretmanu nego pri većim razinama gnojidbe, kao i u prvom periodu uzorkovanja. Sadržaj N u gomolju također nije bio pod značajnim utjecajem gnojidbenih tretmana, kao ni perioda uzorkovanja, a vrijednosti su se kretale od 1,12 % do 1,77 % N. Utvrđen je značajan utjecaj perioda uzorkovanja na sadržaj NO_3-N u svježem soku gomolja, dok gnojidbe različitim dozama dušika nisu izazvale značajne razlike u vrijednostima. Gnojidba rastućim dozama dušika, kao i period uzorkovanja pokazali su značajne razlike u prinosu, a minimalni ostvareni prinos bio je 12,72 t ha^{-1}, dok je maksimalni iznosio 31,07 t ha^{-1}. S obzirom da se radi o lokalnoj autohtonoj sorti krumpira, specifičnoj za uzgoj na brdsko-planinskim predjelima Hercegovine, njezine kvalitativne karakteristike nisu zanemarive u usporedbi sa modernim kultivarima, no izloženost sjemena utjecaju raznih abiotskih i biotskih faktora tijekom godina značajno se odrazio na produktivnost ove sorte.

Ključne riječi: krumpir, autohtona sorta, suha tvar, N, NO_3-N, prinos

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