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Effect of Biofertilization on Yield and Quality of some Potato Cultivars (*Solanum Tuberosum* L.)

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Abstract

An experiment was conducted at the Experimental Farm of Faculty of Agriculture, Assiut University, Egypt in two consecutive winter seasons, 2004-2005 and 2005-06 to determine the effects of three potato cultivars and three biofertilizers (Rhizobacterin, Microbein and Phosphorein) on potato quality and yield under Assiut conditions. Cultivar Diamant gave the highest number of stems per plant, total yield per hectare, highest numbers of marketable tuber yield per plant in the two seasons. The lowest values of the previous characters were recorded in Spunta except total yield of tubers, which was recorded in cv. Cara. Regard to biofertilization treatments, Phosphorein biofertilizer and control treatments gave the highest total yield per hectare in both seasons. Rhizobacterin biofertilizer gave the highest average weight of tubers in both seasons. Control treatment and inoculation of potato seed tubers with different biofertilizer sources gave no significant effect on number of main stem per hill, number of marketable tuber yield per plot in the two fall seasons.

1. Introduction

Potato is the fourth most important food crop of the world and also the most important non-cereal food crop. In Egypt, it is cultivated in an area of 99960 hectares with a production of 2.5 million tonnes. Between 1990 and 2006, the annual potato output rose from 1.6 to 2.5 million tonnes, making Egypt the leading country in Africa as a potato producer. Egypt also ranks among the world's top potato exporters. In 2004, it exported more than 380000 tonnes of fresh potato and 18000 tonnes of frozen potato products, destined mainly for European markets (International Year of the Potato 2008).

One of the major concerns in today's world is the pollution and contamination of soil with the use of excess chemical fertilizers and pesticides. Biological nitrogen and phosphorus, environmentally friendly fertilizers organisms, such as bacteria, fungi and cynobacteria may be considered as the key word for solving such problem. Consequently, this may enhance plant nutrients uptake and promote plant growth (Lampkin, 1990). Biofertilization is now a very important method of providing the plants with their nutritional requirements without having an undesirable impact on the environment (Lampkin, 1990; Abdulla, 1995; Yassin, 2002; Abd El-Malek, 2005 and Abou El-Yazied and Sellim, 2007). In addition, there is now a very fast growing demand for organically grown food products (for both the local and export markets), which helps in the fast spreading of organic and bio-agriculture all over Egypt and in many other countries, especially the developing countries of the southern hemisphere (Abdulla, 1995; Yassin, 2002; Abd El-Malek, 2005). The objective of this study was to investigate the effect of selected commercial nitrogen and phosphorus bio-fertilizers on potato growth, quality and yield of three potato cultivars under Assiut conditions. The results of this work may help in optimizing the growth and quality of potato tuber and increasing its yield.

2. Materials and Methods

Field experiments were conducted at the Experimental Farm of Faculty of Agriculture, Assiut, Egypt in two consecutive fall seasons 2004-05 and 2005-06 to determine the effects of three potato cultivars and three biofertilizers on potato quality and yield under Assiut conditions. Three commercial biofertilizer formulations used in the study are Microbein [a mixture of *Azotobacter chroococcum, Azospirillum lipoferum,* (free living N_2-fixers) and *Bacillus circulants* (Potassium releasing bacteria)], Rhizobacterin is a mixture of *Azotobacter chroococcum* and *Azospirillum lipoferum*] and Phposphorein [mixture of *Bacillus megattueriam var phosphaticum* (a phosphate dissolving bacteria)]. The three potato cultivars used are Diamant, Cara and Spunta obtained from the Potato Growers Cooperative, (PGC), El-Menia Governorate, Egypt.

Biofertilizers were applied by dipping potato seed tubers in a suspension culture of each type of biofertilizers for about 60 min before sowing time. The seed tubers were planted in the field immediately after the incubation treatment. The experimental site was prepared using a conventional method. Experimental plots were consisted of five ridges each of 3 meters in length and 0.7 meter in width forming a plot area of 10.5 m^2. The distances between the hills in the rows was about 30 cm. Split plot in randomized complete block design with four replicates of 50 tubers each were used according to **Snedecor and Cochran (1986)**. The potato cultivars were assigned in the main plots, while the biofertilizer applications were distributed over the sub-plots.

Ammonium nitrate (33.5 % N) @ 720 kg/ hectare and super phosphate (15.5 % P_2O_5) @ 720 kg/ hectare was applied to the control plots. Half ammonium nitrate fertilizer dose was added after complete emergence and the other half was added 30 days later. Super phosphate half of the amount was added broadcasted during soil

preparation prior to seed planting and the other half was side dressed 30 days after emergence. Potassium sulfate was added as usual in potato production field. The plots treated with nitrogen fixation bacteria received half amount of the recommended phosphors fertilizer (46% P_2O_5) before planting and the other half was applied 45 days after planting. Normal cultural practices, irrigation, weeds and pest control were followed as in commercial fields of potato production. Harvesting was done when maturity was attained which was on the 15 February and 10 February, in two autumn seasons of 2005 and 2006. Four parameters viz., number of stems per hill, total yield (ton/hectare), average weight of tuber (g) per plant and percent of marketable tubers weight per plot [sound tubers of medium and large size (> 3 cm diameter)] were recorded in both the seasons. Data of vegetative and yield characters were subjected to statistical analysis using normal F- test and means of treatments were compared using the L.S.D method as reported by Steel and Torrie (1982).

3. Results and Discussion

The results of the experiment are summarized in the figures 1 and 2 and explained in detail below. Cultivars had significant effect on number of stems per hill in the first and second seasons. Cultivar Diamant gave the highest number of main stems per hill followed by Cara cv. While cultivar Spunta gave significantly the lowest number of main stems per hill in the two seasons. These results confirm those obtained by Abdalla (1995) and Awad *et al.* (2002) who reported that number of main stems/plant were significantly higher in cv. Diamant as compared to the other tested cultivars. Opposite findings were recorded by Abou El-Yazied and Selim (2007) who showed that Spunta cultivar recorded the best growth parameters with highest mean tuber weight. Results of this character might be indicating that stem numbers per plant is determinates by genotype. Inoculation of potato seed tubers with different biofertilizer sources had no significant effect on number of main stem per hill in the two seasons. Similar results were reported by many other investigators like Ashour *et al.* (1997) and Awad *et al.* (2002) who stated that number of main stems and tuber dry weight were not significantly affected by chemical and biofertilizers application in both seasons. However, differences in number of main stems/plant, total tuber yield (ton/ hectare.), number of tubers/plant, and tuber average weight (g) as affected by cultivars were significantly recorded in the second season only. Despite the insignificant F values, Phosphorein and Microbein biofertilizers gave the highest number of main stem per hill in the two seasons. These results seem quite logic since Microbein biofertilizer is the only biofertilizer which consisted of two different acting bacteria (N2 releasing bacterium and potassium dissolving bacterium).

Significant differences were found among the three tested cultivars in the two fall seasons. Incongruous potato yields were obtained in all cultivars in the two seasons. In spite of the fact that our results were inconsistent over growing seasons, the highest total yield was always obtained from Diamant cv. in the two seasons. However Spunta cv. ranked the second; however, the differences in total yield between the two cultivars

were significantly higher in the two seasons. Data obtained revealed that total yield in the three cultivars were significantly higher in the first season (2004-2005) compared with the second season (2005-2006). It seems that the relatively higher temperatures (Fig. 1 and 2) prevailing in the first season at planting time, and the relatively lower temperatures prevailing at harvest time, were seasonable for potato plant growth, development and subsequently higher tuber yield. The same trend was recorded by many investigators; they revealed that higher temperature favor vegetative growth and lower temperatures favor tuber growth (Abdalla *et al.* 1995). Total yield related to growth parameters such as number of emerging plants, plant height, stem number and average weight of foliage per plot. Higher yield of Diamant cv. could be due to higher plant stand, number of emerging plants, plant height, stems number and average weight of foliage per plot recorded in the two seasons. Data within hand on vegetative growth factors confirm the previous findings. These results confirm those reported by Abdalla et al. (1995) and Awad *et al.* (2002) they showed that Diamant cv. gave higher total and marketable yields than other cultivars. Opposite findings were recorded by Abou El-Yazied and Sellim (2007). Spunta cultivar recorded the best growth with highest mean tuber weight, nitrate and nitrite tuber content. Different sources of biofertilizer had a conspicuous effect on total yield per hectare in the two fall seasons. Results indicated that Phosphorein biofertilizer followed by control treatment in the first season and control treatment followed by Phosphorein biofertilizer in the second one gave the highest total yield per feddan. This result seems quit logic because both treatments received the normal amount of nitrogen fertilizer. This in turn improved the vegetative growth and subsequently total yield. These results were in agreement with the previous findings of El-Gamal (1996); Ashour *et al* (1997); revealed that inoculation with Phosphorein biofertilizer significantly increased soil available P, number of tubers per hill and total tuber yield. They also found that exportable and total yield were also increased by inoculation with bio-fertilizer or by increasing N application rate. However, inoculation of potato seed tubers with Microbein biofertilizer had a remarkable effect on decreasing total tuber yield per hectare in the two fall seasons. The effect of potato cultivars and biofertilization and their interaction on total yield of tubers are shown in Figure 1and 2. The interaction between cultivars and biofertilization treatments were significant in the two seasons. Potato seed tubers of cultivar Diamant gave the highest total yield per hectare when inoculated with Phosphorein biofertilizer than the other two cultivars in the first and second seasons. However, the lowest total yields per hectare were obtained when seed tubers of cv. Cara were inoculated with Microbein biofertilizer in the two seasons. Generally, inoculated potato seed tubers of cv. Diamant with Phosphorein gave the highest increasing of total yield per hectare in the two seasons of the study.

Distinguish differences were recorded between the three examined cultivars according to average weight of tubers in the two seasons. Spunta gave the highest values of average weight of tubers in the two seasons (85.51 and 99.85 gm in the first and second seasons respectively). Cara gave the lowest values of average weight of tubers (34.50 and 34.83 gm in the two seasons). It is meaning to mention that, Diamant

ranked the second after Spunta in average weight of tubers in the two seasons. It is worth to mention that average weight of tubers is mainly genetically controlled. Abdel-Aal and Imam (1984) reported wide variation in yield and quality of tubers due to high genetic variability among different cultivars of potato under Assiut conditions. Different sources of biofertilization significantly increased average weight of tubers in both seasons. Results indicated that Rhizobacterin biofertilizer, added with the recommended doses of phosphor and potassium inorganic fertilizers, gave the highest average weight of tubers (66.05 and 80.68 gm in the first and second seasons respectively). These findings are in agreement with those obtained by El-Gamal (1996); Ashour *et al.* (1997) reported that larger potato tubers were produced in plots treated with *Azotobacter* or *Phosphobactrin* biofertilizers. In addition, Phosphorein biofertilizer in the first season and the control treatment in the second year ranked the second. El-Gamal (1996) and Ashour *et al.* (1997) found that increasing N application rate or inoculation with bio-fertilizers resulted in higher average tuber weight. The lowest average weight of tubers was obtained from Microbein biofertilizer in the two seasons (55.45 and 55.13 gm). The interaction between potato cultivars and biofertilization was significant in the two seasons. On one hand, Rhizobacterin biofertilizer treatment resulted in an increase of average weight of tubers in cv. Spunta in both seasons. On the other hand while this biofertilizer resulted in a depressing effect in case of cv. Cara.

Significant differences were found among the three tested cultivars in the second season, but did not reach the significant level in the first season. Spunta cv. gave the highest and Cara gave the lowest percentage of marketable tuber yield per hectare. Ismail (1998) found that Spunta showed earlier emergence, better standing percentage, higher weight of tubers per hill, and heavier marketable and total yields per hectare. Data in figure 1 and 2presents the effect of inoculation of potato seed tubers with different sources of biofertilizer on percentage of the marketable tuber yield per hectare in the two fall seasons. The results indicated that Phosphorein biofertilizer followed by Microbein treatment gave an equal percent of marketable tuber yields per hectare in the two seasons. Potato seed tubers inoculated with Rhizobacterin biofertilizer gave significantly the lowest percent of marketable tuber yield per hectare in the last season. The effect of potato cultivars and biofertilization and their interaction on percentage of marketable tuber yield per hectare are shown in figure 1 and 2. The interaction between cultivars and biofertilization treatments was not significant in the two seasons. Generally, inoculated potato seed tubers of cv. Spunta with Phosphorein gave the highest percentage of marketable tubers per hectare in the two seasons of the study.

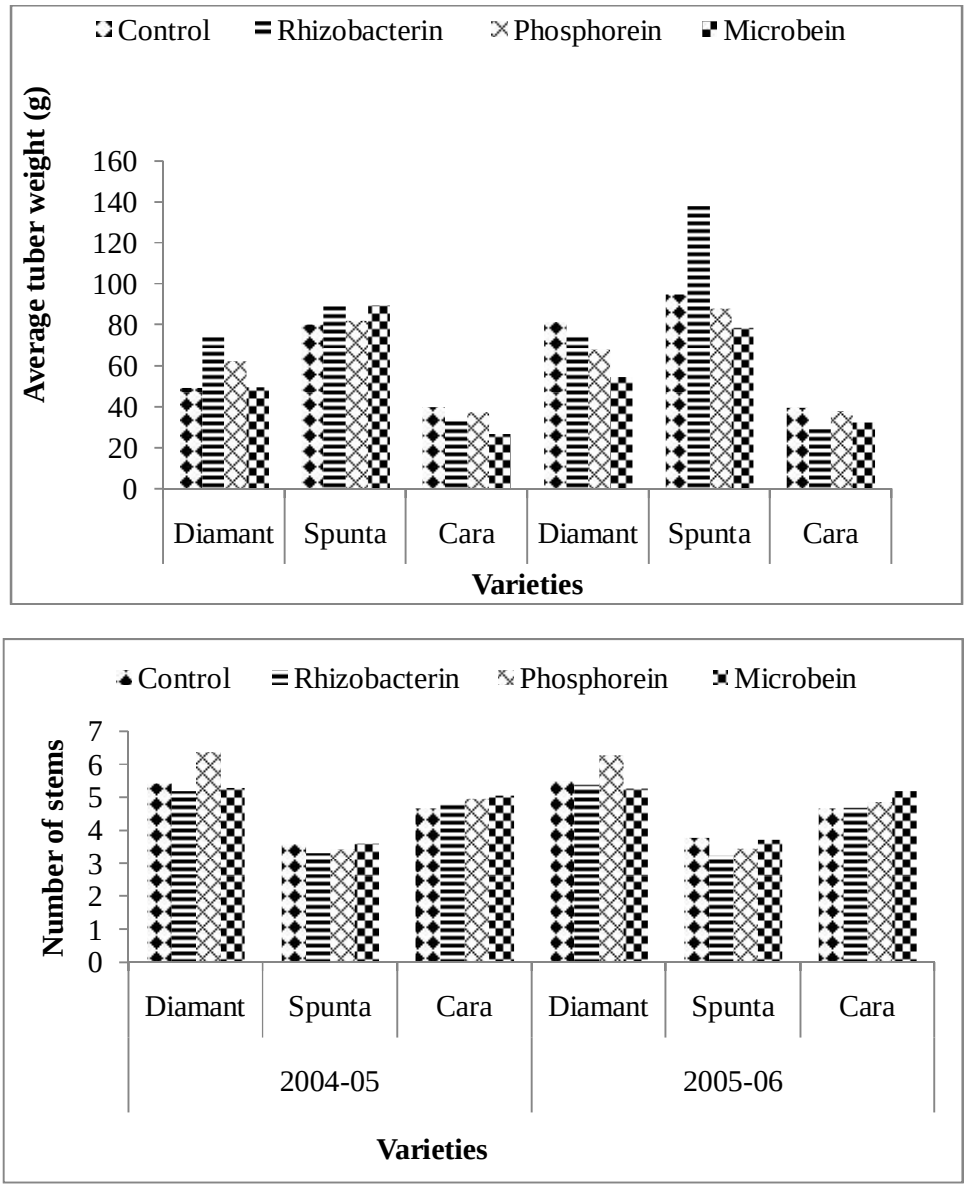

Figure 1: Average tuber weight (g) and number of stems after 90 days of the three potato cultivars as affected by biofertilization treatments during the two fall seasons of 2004/2005 and 2005/2006.

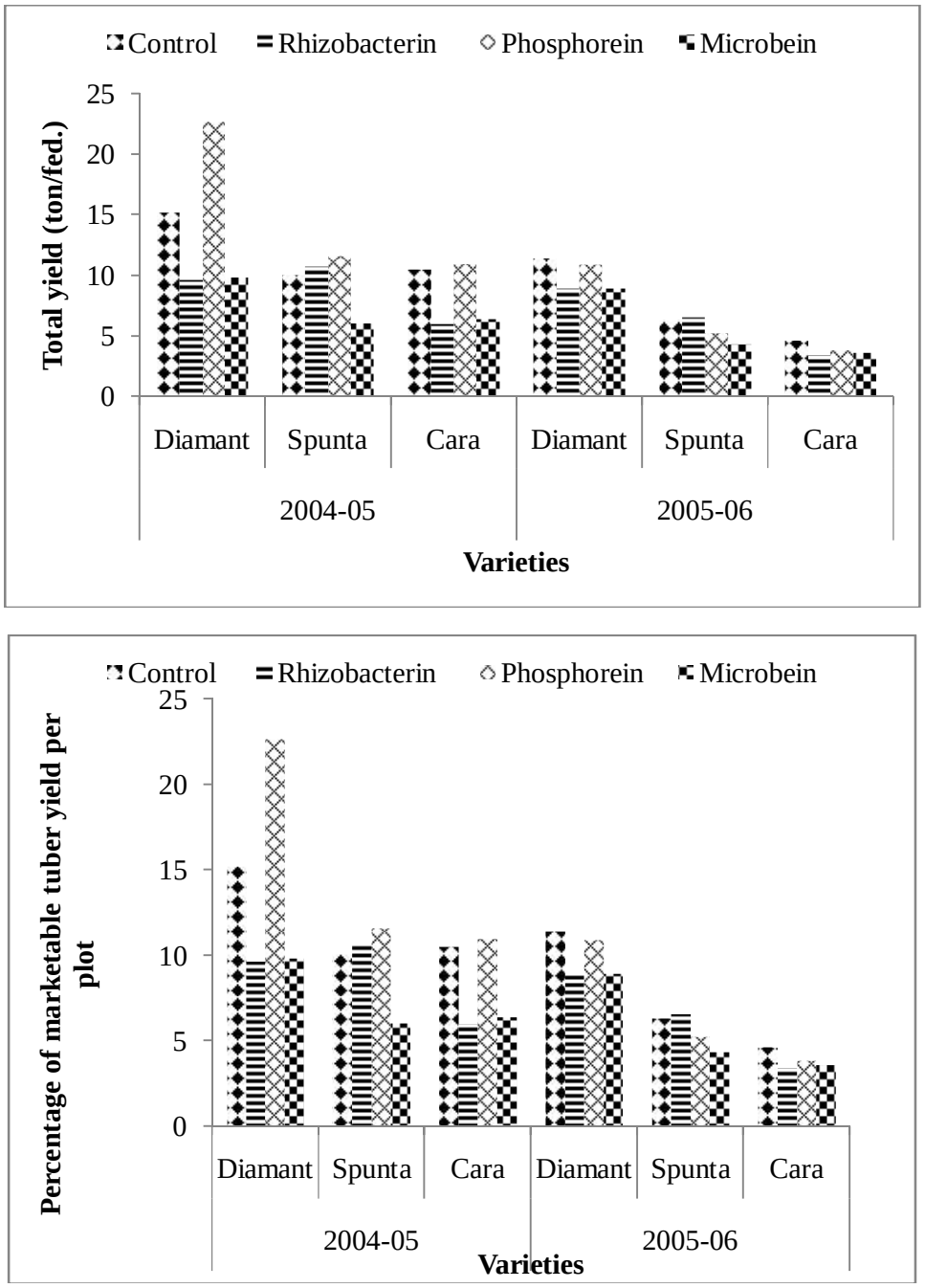

Figure 2: Total yield (ton/ hectare.) and percentage of marketable tuber yield per plot of the three potato cultivars as affected by biofertilization treatments during the two fall seasons of 2004/2005 and 2005/2006.

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