CHANGE IN GROWTH AND PRODUCTIVITY OF BURGUNDY DUE TO ROCK PHOSPHATE, VAM AND *RHIZOBIUM* INOCULATION

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ABSTRACT

Rhizobium, VAM and rock phosphate inoculation has a significant utilization in burgundy. The present study was conducted to study the influence of rock phosphorus fertilization, Vesicular Arbuscular Mycorrhizae (VAM) and rhizobium inoculation on growth and yield parameters of burgundy (Macroptilum bracteatum). The experiment was laid out in randomized complete block design during summer season at the Department of Botany University of Peshawar Pakistan. A composite soil sample was collected for analysis of soil for physical and chemical properties. Rock phosphorus fertilization, application along with VAM and rhizobium inoculation increased the growth parameters significantly. Inoculation under "P" deficient soil dual inoculation, Rhizobium and VAM resulted in an increase in grain yield respectively, over no inoculation in Macroptilum bracteatum. Maximum growth was observed where VAM along with rhizobium and rock phosphate inoculation were applied. It is concluded that burgundy should preferably be grown with dual inoculation of VAM along with rhizobium and rock phosphate.

Keywords: **Burgundy, *Rhizobium*, RP fertilizer, inoculation, productivity**

Citation: Yaseen T., F. Hussain., H. U. Rehman and M. Noor. 2013. Change in growth and productivity of burgundy due to rock phosphate, vam and *rhizobium* inoculation. Sarhad J. Agric. 29(4): 537-542

INTRODUCTION

Arbuscular mycorrhiza (AM) contain widespread symbiotic interactions that are commonly described as the result of co-evolution between fungi and plants, where both partners benefit from the reciprocal nutrient exchange (Bonfante and Genre, 2008). Arbuscular mycorrhiza symbiosis is witnessed in approximately 80% of vascular plant species in all major terrestrial biomes (Feddermann *et al*., 2010; Smith *et al.,* 2010).

Dual inoculation with both microorganisms results in a tripartite mutualistic symbiosis and generally increases plant growth to a greater extent than inoculation with only one (Chalk *et al*., 2006). Inoculation alone or a combination of beneficial microorganisms including AMF, rhizobia, PGPR and PSB (Phosphate Solubilizing Bacteria) have been observed to increase production in green gram and chickpea, nitrogen fixation and nutrient uptake (Kushwaha**,** 2007; Jain *et al.,* 2007; Rahman *et al.,* 2008; Jain *et al.,* 2008; Ray and Valsalakumar, 2009;Pir *et al.,* 2009; Akhtar and Siddiqui, 2009; Jain *et al.,* 2009; Singh and Singh, 2010; Thenua *et al.,* 2010; Hussain *et al*., 2013; Murat *et al.* 2011) reported that AMF inoculation, alone or in combination with rhizobial inoculation, increased in yield, root colonization and phosphorus content of the seed and shoot.

The research was carried out to evaluate the beneficial effect of bio-fertilizer (VAM, *Rhizobium* and Rock phosphate) inoculation alone and in combination on growth and productivity of burgundy.

MATERIALS AND METHODS

The study was conducted during summer at the department of Botany University of Peshawar Pakistan. The mean maximum temperature in summer is over 40 °C (104 °F). Seeds of burgundy were sown in circular earthen pots (21 cm height and 70.6cm diameter) filled with a mixture of soil which was sterilized in Laboratory of Soil and Environmental Science department, Agricultural University Peshawar. The sample was mixed with sand in ratio of 2:1 (v/v). Rhizobia and AMF propagules were mixed. Rhizospheric soil from wheat field having high spore number of different AMF i-e *Glomus fasciculatum, G. mosseae* and *G. aggregatum* and roots of wheat and maize infected with Arbuscular mycorrhiza were used as rhizobase inoculum. The root pieces along with soil base inoculum (rhizospheric soil) were spread uniformly in layers at a depth of 3cm and 6cm before sowing. Inoculum for each pot consisted of 180 g of mycorrhizal infected roots and adhering soil. *Rhizobium* seed inoculation was done by using effective *Rhizobium leguminosarum,* obtained from Dept. of Soil Science, National Agriculture Research Center, Islamabad. The seeds were coated with gum acacia and 10 kg pot^{-1} soil was used. Soil used during the experiment was collected from the University of Peshawar. The soil was air-dried, sieved through 4 mm sieve and characteristics determined at the soil laboratory of the department of Soil and Environmental Science, The

University of Agriculture, Peshawar. Characteristics of the soil were as follows; soil texture as sandy loam, organic matter 6.65 percent, nitrogen 0.044 percent and phosphorus 1.13 percent (Olsen and Sommers, 1982). The pH of saturated paste (7.30) was determined by pH meter as recommended by Richard *et al.* (1954).Seeds were inoculated individually with *Rhizobium* and AM fungi (applied as layering on soil surface) and combination of both and different levels of rock phosphate fertilizer. The plants were irrigated with tap water as and when required. The plants were collected from each replication for sampling at vegetative, flowering and fruiting stages after sowing. The data related to the plant height, pods plant^{-1} and seeds pod^{-1} was recorded on 45th day. The following treatments were used in the study;

T1 =Control (Un inoculated),

T2 =Inoculation with VAM fungus alone,

T3 =Inoculation with *Rhizobium* alone,

T4 =Inoculation with *Rhizobium* + VAM (Dual inoculation),

T5 =Application with Rock phosphate alone,

T6 =Inoculation with Rock phosphate +VAM (Dual inoculation)

T7 =Inoculation with *Rhizobium* + VAM + Rock phosphate.

Statistical Analysis

Experimental data was statistically analyzed using the Statistical Analysis System (SAS, 1998) program, the means were subjected to LSD test after revealing differences among treatments (Khan *et al.,* 2008).

RESULTS AND DISCUSSION

Plant Height

The ANOVA revealed highly significant differences among the treatments for plant height at harvesting stage. It is evident from the data that with the use of treatment of bio-fertilizer enhanced plant height compared to the control. Our results correlate with the findings of Jia *et al.,* 2004; Bhuiyan, 2004 that both rhizobial and mycorrhizal symbiosis can act synergistically on promoting plant growth. It is evident from our data that VAM inoculation improved plant growth expressed as plant height compared with the uninoculated plants (Table 1). Our results were in-line with the findings of Jarande et al. (2006) who stated that treatments which included rock phosphate (RP) and seed treatment with phosphate solubilizing bacteria (PSB) and *Rhizobium* application RP+PSB+*Rhizobium* recorded higher values of growth parameters including plant height, number of branches per plant, number of seeds per plant and pod length. Our results are also in-line with the findings of Rajasekaran and Nagarajan2005; Mortimer et al. 2007; Kushwaha, 2007; Khan et al. 2008; Nishita and Joshi, 2010; Nazir et al. 2011. The lowest plant height was recorded for control (Table 1). Our findings were supported Hani (2009) who reported significant effects of bio-fertilizer on plant height. RHZ+VAM and VAM+RP produced the highest plant height which was higher than control in burgundy. This result is in agreement with that of Shivakumar and Sidramappa (2004), they reported that plant height of soybean was highest with 20 kg P ha-^{1}. Same observation were also reported by Mortimer et al. (2007) stating that synergistic effects of the combined application of rhizobia and AM fungi enhance plant growth to a greater extent than singular inoculation. Maximum height was attained in mycorrhizal and rhizobium treatments in combined form as shown in Table 1. Our result agree with the finding of Jia et al. (2004) who reported that inoculation with AM fungi promoted biomass production and photosynthetic rates in *Vicia faba* because of the enhanced P supply due to AM fungi inoculation. The plant height gradually increased with increase in the RP+VAM level (Table 1). Our findings were in-line with Hussain *et al.* (2010) who studied the influence of phosphorus fertilization and *Rhizobium* inoculation on growth and yield parameters of mungbean (*Vigna radiata*).

Number of Leaves Plant^{-1}

Data regarding number of leaves plant^{-1} revealed highly significant differences for bio-fertilizer treatments. Mean values for number of leaves plant^{-1}at different bio-fertilizer are given in Table 1. Significance of treatments effect showed that bio-fertilizer application has an observable effect on number of leaves plan^{-1}. Our results are in accordance with Gilani and Bharose (2004) who studied the effect of bio-fertilizers on the growth and yield of green gram (*Vigna radiata*). Different levels of rock phosphate and bio-fertilizer (*Rhizobium* and VAM) were applied resulted in significant effect on number of leaves (Table 1). Our results were supported by Balachandran et al.

(2005) who reported that the effect of seed inoculation with *Rhizobium* and phosphate solubilizing bacteria (Rh + PSB) significantly increased plant height, number of branches, number of leaves and leaf area.

Table 1. ***Mean values for plant height (PH1), number of leaves (NL1) at flowering stage, plant height (PH2), number of leaves (NL2), number of flowers at flowering stage, plant height (PH3), number of leaves (NL3), number of pods plant^{-1}, pod length and number of seeds pod^{-1} under different bio-fertilizer treatments.***

	PH1	NL1	PH2	NL2	#FLWR	PH3	NL3	#Pod	PdL	#Seed
Control	13.70d	6.40ab	27.50b	5.80a	2.20b	30.12d	4.40a	2.20b	3.52c	10.40e
VAM	19.40bc	7.80a	30.24b	6.00a	3.00ab	35.86b	2.80b	2.80b	5.54ab	13.80cd
Rhizobium	17.90c	5.20b	35.58a	3.20b	3.20ab	33.98c	4.20a	2.40b	5.12b	12.20de
Rhizobium+VAM	22.30a	6.20ab	37.82a	5.00a	3.80a	38.44a	4.80a	3.80a	6.24a	16.00ab
Rock phosphate	15.10d	4.80b	27.98b	3.20b	3.20ab	33.98c	4.20a	2.40b	5.24b	14.40bc
Rock phosphate+VAM	19.70b	5.20b	36.38a	3.20b	3.20ab	38.38a	4.20a	2.40b	5.60ab	14.80abc
Rhizobium+VAM+Rock phosphate	21.50a	5.20b	37.98a	3.20b	3.20ab	39.18a	4.20a	2.40b	6.44a	16.40a
LSD	**1.66**	**1.66**	**4.92**	**1.62**	**1.00**	**1.50**	**0.73**	**0.80**	**0.96**	**1.86**
Significance	**	**	**	**	*	**	**	**	**	**

** = Significant at 1% probability
* = Significant at 5% probability

Number of Pods per Plant

The ANOVA for number of pods plant^{-1} showed highly significant differences among bio-fertilizer treatments at harvesting stage. Our results were supported by Jain et al., (2009) who reported that combined inoculation of *G. intraradices* with *P. straita* plus *Rhizobium* to pathogen inoculated plants resulted greater increase in plant growth and number of pods than by inoculation of *G. intraradices* plus *Rhizobium* or *G. intraradices* plus *P. straita* alone. Different levels of mycorrhizal *Rhizobium* phosphate (MRP) and bio-fertilizer were applied resulting in significant number of seeds per pod, number of pods plant^{-1} (Table 1). Similar findings have been reported by Jalaluddin (2005) that combined inoculation of VAM fungus, *Glomus macrocarpum* and *Bradyrhizobium japonicum* in soybean variety William 82. Our findings showed that VAM produced significantly better growth attributes when combined with RP or Rhz as compared to the yield and yield attributes over rest of the bio-fertilizers and fertilizer (RP) alone. Our results are supported by findings of Khan et al. (2005) who reported the effect of seed inoculation with *Rhizobium* along with various levels of phosphorus on chickpea (cv. Karak-1) growth produced significant increase in pods per plant.

Pod Length

Analysis of variance regarding pod length depicted highly significant differences among bio-fertilizer treatments at fruiting stage. Mean values of pod length related to the VAM, RHZ, RHZ +VAM, RP and VAM+RP inoculation treatments on number of pods plant^{-1} of *Macroptilum bracteatum* following seven treatments are given in Table 1.Maximum pod length (6.44cm) was observed at MRP 260 mg(Table 1). Similar results of significant differences for pod length have been reported by Jagvir et al. (2004) mentioning dual inoculation of *Rhizobium* and VAM result in increase in grain yield, over no inoculation for the yield of green gram, viz., pods per plant, pod length, seeds per pod, 1000-seed weight and seed yield per plant.

Number of Seeds per Pod

Highly significant differences were observed among treatments for number of seeds pod^{-1} at harvesting stage. The highest number of seeds pod^{-1} were found in MRP treatment which was higher than control (Table 1). These findings coincide with those of Jagvir *et al.* (2004) who concluded that dual inoculation, *Rhizobium* and VAM resulted in increase in grain yield, over no inoculation. Our results are further supported by the findings of Chatterjee and Bhattacharjee (2002) who reported that the percentage increase in grain yield over control was observed to be significantly higher in plants inoculated with *Rhizobium* strains and phosphate solubilizing bacteria. Similar results were obtained by Jarande et al. (2006) who stated that treatments which included rock phosphate (RP) and seed treatment with phosphate solubilizing bacteria (PSB) and *Rhizobium* application of RP and PSB+*Rhizobium* recorded higher values of growth as well as yield. Our results are also supported by Meghvansi and Mahna (2009), who found that dual inoculation of *rhzobium* + VAM was superior over single inoculation.

CONCLUSIONS AND RECOMMENDATIONS

Seven treatments viz; Control, VAM, *Rhizobium*, *Rhizobium*+VAM, Rock phosphate, Rock phosphate+VAM and Rock phosphate+VAM applied during the experiment conducted at the Department of Botany, University of Peshawar, Pakistan were studied to investigate the effect of different bio-fertilizer treatments on growth of burgundy. Rock phosphorus fertilization alone, application along with VAM and *Rhizobium* inoculation increased the growth parameters significantly. Maximum number of pods plant^{-1}were observed where VAM along with *Rhizobium* inoculation was applied. It is concluded that burgundy should preferably be grown with dual inoculation of VAM along with *Rhizobium* and rock phosphate.

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