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Assessment of Sowing Date impacts on productivity of different Grass pea ecotypes

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ABSTRACT: Grass pea (*Lathyrus sativus* L.) is one of the essential food legumes in some developing countries with great forage production potential. The main goal of this study was to evaluate the influence of different sowing dates on yield and yield components of various grass pea ecotypes in the semi-arid region of Iran. Three years experiments (2009 to 2011) were performed through factorial based on randomized complete block design with three replications. Three levels of sowing dates included: mid April (S1), early May (S2) and end of May (S3) and four ecotypes of grass pea which originated from different regions (Syria (E1), Ethiopia (E2), Oshnaveye (local ecotype) (E3) and Mashhad (local ecotype) (E4)) were employed in this study. Pod number per ground m^{-2}, pod weight per ground m^{-2}, seed number per pod and thousand seed weight were measured in this study. The results showed that all study parameters were influenced by different sowing dates and grass pea ecotypes. Second sowing date resulted in the highest biological (680 g m^{-2} in 2010) and seed yield (254 g m^{-2} in 2011). There was significant negative correlation between average maximum temperatures and biological and seed yield of grass pea across all ecotypes, years and locations. Syria and Mashhad ecotypes achieved highest biological and seed yield across study ecotypes under first and second sowing dates. In conclusion, insignificant delay in grass pea sowing date for avoiding lower temperatures and higher temperatures during early and end of growth period could be suitable pattern, further to selection of appropriate ecotype to achieve highest yield.

***Keywords*:** Grass pea; Ecotype; Sowing date; Yield; Yield components

INTRODUCTION

Legumes are significant crops treasured for their place in crop rotations and as food and feed sources (Grela, 1999). Grass pea (*Lathyrus sativus* L.) has high production potential, drought and salt tolerance, disease resistance and is a critical food crop for animals and humans in some countries in West Asia and North Africa such as Nepal, Bangladesh, India and Ethiopia (Mahboob, 2000; Polignano, 2003; Campbell, 1997). Grass pea is a winter season crop adapted to the subtropics or temperate regions (Mehta, 1994). Grass pea cultivation area is between 3000 to 6000 (ha) under cold conditions of Northwest of Iran (Morsali , 2008). The protein content of grass pea seeds is similar to or flushes higher than some commonly consumed grain legumes such as pea (Zambre, 2002). However, high percentage of the neurotoxin b-N-oxalyl-L-a,b-diamino- propionic acid (ODAP) that causes paralysis of the lower limbs in humans is the main limit of wider cultivation of this crop (Hanbury, 2000). Grass pea might become a useful rotation crop in the infertile soil zone of the Canadian prairies, an area that lacks an adapted annual legume alternative (Wang, 1998).

Sowing date moderately influence the quantity (Singh, 1998) and quality (Gul, 2008) of agricultural products, through exposing the crops to diverse environmental conditions. Sowing date also affects the grain protein percentage mainly through pattern of the thermal conditions prevailing during the grain filling period (Alignan, 2009). Usually late sowing date cause late flowering, thereby forcing the grain filling period to coincide to a high temperature regime (Vos and Putten, 1997). Extreme temperature and drought occurrence during grain filling have been identified as a major source of variation of seed quality characteristics (Singh, 2010). He, (1998) showed that early planting decreased economic yield of potato by lower temperature than optimum levels during tuber filling period. Under soil moisture limitation, planting too early to capture higher portion of the fall rainfall can cause excessive fall growth which usually result in decline of available soil moisture for early spring growth (Winter and Musick, 1993). Piergiovanni, (2010) evaluated fourteen different ecotypes of grass pea under various climate conditions and found sharply diversity across different grass pea ecotypes productivity under various temperature regimes. Changes in harvesting date significantly changes dry matter production in pea plants by increasing in growth period (Fraser et al., 2001). However, 30 days delay in sowing date of forage rape remarkably decline total dry matter production by increasing in temperature from optimum temperature in early growth period (Keogh, 2011). In addition, late sowing dates significantly decrease Pigeon pea (*Cajanus cajan* L.) grain yield (Kumar, 2008). Connor, (1993) reported earlier sowing (late April to early May) increased N_2 fixation and larger dry matter production in compare to late sowing dates.

The main goals of this study were to evaluation of the yield and yield components response of four ecotypes of Grass pea (*Lathyrus sativus* L.) to different sowing dates.

MATERIALS AND METHODS

Study area

This study was performed from 2009 to 2010 growing seasons at the experiment station of the Tarbiat Modares University (latitude: 35˚43' N, longitude: 51˚08' Elevation: 1215 m) in the Tehran province of Iran. Third year of this study was carried out in 2011 at Ferdowsi University of Mashhad (latitude: 36˚15' N, longitude: 59˚28' Elevation: 999 m) which situated in Northwest of Iran. Climatic conditions of Tehran and Khorasan provinces are quite similar (semi-arid). Annual precipitation amount in Tehran and Khorasan provinces are 236 and 250 mm for central parts (study location), respectively. Maximum and minimum temperatures and precipitation rate of all years of study are shown in Fig. 1. In addition, the soil properties of study locations were represented in Table 1.

Experimental design and field conditions

This experiment was carried out by using a factorial based on randomized complete block design with three replications for all study years. Three levels of sowing dates included: mid April (S1), early May (S2) and end of May (S3) and four ecotypes of grass pea which originated from different regions (Syria (E1), Ethiopia (E2), Oshnaveye (local ecotype) (E3) and Mashhad (local ecotype) (E4)) were employed in this study. All plots were fertilized uniformly by 300 $kg.ha^{-1}$ triple superphosphate pre-planting. Six rows of grass pea seeds were planted in piles (4 seeds for each pile). The size of each plot was 4.2m × 3m. Irrigation schedule performed in 5 days intervals immediately after planting. Weeds were controlled by hand when needed. Plants were cut in full 80% flowering stage on 27 March for early sowing dates to 28 May for later sowing dates in all years of study at both locations.

Plant measurements

Yield and yield components included: pod number per m^{-2}, pod weight per m^{-2}, seed number per pod and thousand seed weight, measured by 1 m^{-2} sampling from each plot. Collected materials were weighted after drying in a heater at 45 ºC for 72 h. Final biological and seed yield measured by collecting plants materials from 2.5 m^{-2} of each plot. Harvest index (%) calculated as the ratio of seed yield to biological yield.

Statistical analysis

In order to evaluate the treatments impacts on study parameters, analysis of variance (ANOVA) was performed as standard procedure for factorial randomized block designs. The t-test was used to find significant differences among treatments. The significant differences between treatments were compared by Duncan’s multiple range tests at 5% probability level.

RESULTS AND DISCUSSION

Sowing date

Pod number and pod weight were statistically influenced (P > 0.05) by different sowing dates in all years of experiment (Table 2). Highest plant Pod number and pod weight gained at second sowing date in Tehran location (577 per m^{-2} and 272 in g m^{-2} in 2009, 692 per m^{-2} and 310 g m^{-2} in 2010) and first sowing date in Mashhad location (763 per m^{-2} and 217 in g m^{-2} in 2011) (Table 2)., Various sowing dates also showed significant impact (P > 0.05) on thousand seed weight and seed number in all years of study (Table 2). Second sowing date indicated highest thousand seed weight and seed number in both years of experiment at Tehran locations (143 g and 2.9 in 2009, 139 g and 2.9 in 2010). However, first sowing date showed utmost values of thousand seed weight and seed number (151 g and 2.5) at Mashhad location (Table 2).

Biological and seed yield showed significant response to different sowing dates in all years of study (Table 2). Highest biological (606 and 680 g m^{-2} in 2009 and 2010, respectively) and seed (207, 255 and 254 g m^{-2} in 2009, 2010 and 2011, respectively) yields obtained at second sowing in all years of experiment except seed yield in 2011 at Mashhad location which highest yield obtained in first sowing date (645 g m^{-2}) (Table 2). On the other hand, lowest yield and yield components values obtained under third sowing date in all years of study. In addition, grass pea plants did not flowered at third sowing date in Mashhad location (2011) therefore there was no seed yield on that year (Table 2) for third sowing date.

Different sowing dates illustrated a high impact on harvest index in all years of study (Fig. 2). Maximum harvest index obtained at second sowing date in Tehran location (56% for 2009 and 33% in 2010); furthermore, first sowing date showed highest harvest index (40%) in 2011 at Mashhad location (Fig. 2).

Grass pea ecotypes

Each study ecotype of grass pea was adapted in different regions of world and Iran. Various ecotypes of grass pea showed significantly different (P > 0.05) on pod number and weight in all years of the experiment (Table 3). Maximum pod number and weight was obtained in Mashhad (637 per m^{-2} and 272 in g m^{-2} in 2009, 671 per m^{-2} and 267 g m^{-2} in 2010) and Syria (900 per m^{-2} and 196 g m^{-2} in 2010) ecotypes in Tehran and Mashhad locations (Table 3). Thousand seed weight and seed number were statistically influenced by various ecotypes of grass pea in all years of study (P > 0.05) (Table 3). Highest thousand seed weight was gained by Syria ecotype under Tehran conditions and Mashhad ecotype at Mashhad location (Table 3) while maximum seed number was obtained by Mashhad ecotype (3.1, 3.0 and 1.7 seed per pod in 2009, 2010 and 2011, respectively) in all years of study.

There were marked differences of biological and seed yields of various grass pea ecotypes (Table 3). Syria ecotype showed highest biological (580, 610 and 679 g m^{-2} in 2009, 2010 and 2011, respectively) and seed (202, 184 and 275 g m^{-2} in 2009, 2010 and 2011, respectively) yield in all years of study at both locations, however there was no significant difference between Syria and Mashhad ecotypes in nearly all cases (Table 3). Ethiopia ecotype illustrated lowest values of biological and seed yields across all years of this experiment (Table 3). However, Ethiopia ecotype showed maximum harvest index in all study years except 2011 which Syria ecotype showed utmost harvest index at Mashhad location (Fig. 2).

Interactive effects of different sowing dates and grass pea ecotypes

Biological and seed yield

Remarkable differences in biological and seed yields were monitored across all study years (Table 4). Mashhad and Syria ecotype were the most productive ecotypes compared to others under various sowing dates. Highest biological (136 g m^{-2}) and seed (62 g m^{-2}) yields of grass pea obtained at second sowing date (early May) by Syria ecotype in 2011 (Table 4). Generally, 20 days delay in cultivation of grass pea from first to second sowing date indicated higher positive interaction (10% to 60 %) of the two sowing dates for biological and seed yields (Table 4).

Harvest index

Ethiopia ecotype indicated maximum harvest index (68% under third sowing date in 2009 and 40% under second sowing date in 2010) at Tehran location. On the other hand, Syria ecotype showed highest harvest index (51%) under first sowing date conditions at Mashhad location in 2011 (Table 4). In general, 20 days delay in sowing date between first and second sowing date indicated utmost increase in harvest index across 20% to 60% (Table 4).

DISCUSSION

The results illustrated that by sowing the grass pea at the early may it was possible to maximize the production of this plant through avoiding low temperature of early growth period and higher temperature during the end of growth period (Fraser, 2001). In addition, different ecotypes of grass pea have potential to indicate various pod number, pod weight, thousand seed weight, seed number and seed yield. Slight delay (mid April (S1) to early May (S2)) in sowing date of grass pea in both study locations resulted in higher production of seed and forage. Second sowing date indicated highest values of biological and seed yields in this study. Piergiovanni, (2010) reported significant increase and decline in biological and seed yield of different grass pea ecotypes under different climatic conditions in Italy. It seems higher maximum temperatures during growth period of grass pea played a vital role in determination of biological and seed yield of this plant (Fig. 3). Furthermore, low temperature occurrence in early growth period might be the main cause of grass pea production decline in first sowing date (Fig. 1).

According to the results, there was significant negative relationship between maximum and minimum temperatures against biological and seed yield of grass pea (Fig. 3 and 4). Grass pea production showed lowest performance on third sowing date because of higher values of maximum temperature on growth period and lowest growth period on that sowing date (Fig. 1). Second sowing date represented highest production of grass pea with highest values of pod number and seed number on that sowing date. Syria and Mashhad ecotypes biological and seed yields showed better response in comparison with Oshnaveye and Ethiopia ecotypes in all years of study, especially in third sowing date (Table 4). These ecotypes showed higher performance in dry matter production because of the evolution of those ecotypes was carried out in temperate environment and they were adapted to moderate climate. Ethiopia ecotypes showed lowest performance under these experiment climatic conditions owing to the fact that this ecotype evolution is on dry conditions of Africa. Thus, Ethiopia ecotypes might not show outclass in compare to other ecotypes on moderate conditions.

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