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Roles of methanol and ascorbic acid foliar application on physiological traits of peanut (*Arachis hypogaea* L.) under rainfed condition

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Abstract

Peanut is an agriculturally valuable plant with widespread distribution in the world serving as a subsistence food crop as well as a source of various food products. In order to evaluation the effect of foliar application of methanol and ascorbic acid on physiological traits (crop growth rate, pod growth rate, partitioning factor and pod filling period) of peanut (*Arachis hypogaea* L. var.NC2) an experiment was conducted in agricultural research farm of Astaneh Ashrafiyeh (north of Iran) in 2013-2014. A completely randomized block design with three replication on a factorial experiment with two factors including four levels of methanol (0 (Control), 10, 20, and 30 volumetric percentage) and four levels of ascorbic acid (0 (Control), 1000, 2000, and 3000 mg/lit) was used. Methanol and ascorbic acid foliar application was done two times during the growing season with 15 days intervals and spraying start in 73 code stage of BBCH-scale. The results indicated that, the application of methanol and ascorbic acid in different concentrations showed significant increases in all physiological traits (apart from pod filling period) compared with control treatment. Most significant effects were obtained by spraying 20-30 (v/v) methanol and (2000-3000 mg/lit) ascorbic acid at the two application dates. Correlation coefficients among crop growth rate, pod growth rate and partitioning factor were positive and significant, whereas they were negatively and significantly correlated with pod filling period. Therefore, the knowledge of crop physiology through various analysis technique, which involves tracing the history of growth and identifying growth and yield factors contributing for yield variation is a vital tool in understanding the crop behaviour.

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Introduction

Peanut (*Arachis hypogaea* L.) is grown as an important crop in a wide range of environments between latitudes of 40◦N and 40◦S. Two-thirds of the global production occurs in rainfed areas of the semiarid tropics which are characterized by unpredictable periods of water deficit (Reddy *et al.,* 2003). Peanut flowering and pod filling are quiet sensitive to drought stress (Haro *et al.,* 2007; Haro *et al.,* 2008), thus water deficit periods affecting these phenological stages may have a large negative impact on yield. Conceptually, the yield of a determinate grain crop is a function of the number of grains set and the size of grain. Grain number is strongly influenced by the rate of crop growth around flowering. Grain size, however, is affected by both the crop growth rate after flowering and the mobilization of pre-anthesis assimilate. The timing of the different stages of phenological development, particularly flowering, is controlled by both genetics and environment, mainly temperature and photoperiod. Dry matter accumulation between two successive phenological events is the result of crop growth rate and the duration of the phenological phase. Crop growth rate is a function of the ability of the crop to capture light, nutrients, and water and the efficiency of their use, both of which are influenced by genetics and environment. The pattern of the dry matter production and its distribution into component plant parts has been of phenomenal interest to the research workers engaged in yield analysis. This method has been accepted as one of the standard method of yield analysis. All the physiological processes results into a net balance and accumulation of dry matter and hence, the biological productivity of plant is judged from their actual ability to produce and accumulate dry matter. Rate of growth and growth duration are integrated into conceptual variables largely correlated with yield or total biomass accumulation (Hammer *et al.,* 2005; Yin *et al.,* 2004). Because yield is a complex trait, dissecting it into component traits is an effective approach in analyzing its physiological determinants since physiological factors and developmental growth stages affecting expression of yield component traits differ. For most species and growing conditions, variation in grain yield is largely accounted for by the variation in number of seeds. Individual grain mass is much more stable and contributes less to yield variation in general. Understanding the regulation of the number of seeds is therefore central to understanding grain yield determination (Andrade *et al.,* 2005; Haroa *et al.,* 2015; Phakamas *et al.,* 2008). Plant-emitted gaseous methanol is an abundant, volatile organic compound that was considered for a long time to be a waste product of plant metabolism. Now, the diverse biological effects of methanol have been discovered and demonstrated. The main source of plant methanol release is the above-ground parts of the plant (O'Keefe *et al.,* 2014). Plant tissues have been shown to metabolize methanol (Downie *et al.,* 2004). The majority of endogenous methanol reaches the leaf surface and evaporates, and a minor amount is nonenzymatically oxidized to formaldehyde, which could later be involved in the synthesis of serine, methionine, and phosphatidylcholine. In addition, methanol could be enzymatically oxidized to Carbon dioxide (CO_2) and then directed to the Calvin cycle (Downie *et al.,* 2004). Methanol metabolism in plants can be accompanied by significant increases in biomass; in some C3 plants, this is often accompanied by an increased photosynthetic efficiency and developmental rate (Downie et al., 2004, Nonomura and Beson, 1992). Moreover, plantgenerated methanol could be involved in leaf growth during plant development (Komarova *et al.,* 2014). Small amounts of methanol emitted through the stomata are oxidized to carbon dioxide by methylotrophic bacteria either directly on the leaves or later in the soil (Kolb, 2009). In general, methanol is a rather stable substance under normal conditions with a half-life of ~ 10 days (Jacob *et al.,* 2005).

Vitamins are compounds that are required in relatively small amounts but that cannot be synthesized in quantities large enough to meet the normal needs of the organism. Vitamins could be considered natural and safety bio-regulator compounds which relatively in low concentrations exerted profound influences upon many physiological processes. Vitamin C is referred to as ascorbic acid. It is one of the most important water soluble antioxidants in plants that have synergistic effects on growth, yield and yield quality of many plant species. These compounds have beneficial effects on catching the free radicals or the active oxygen that produced during photosynthesis and respiration processes (Zhang, 2013; Pastori *et al.,* 2003; Smirnoff, 2011). Ascorbic acid has antioxidant properties and acts as a primary substrate in the pathway for enzymatic detoxification such as H_2O_2. Ascorbic acid participates in a variety of processes including photosynthesis, cell wall growth and cell expansion, gibberellins, anthocyanin and hydroxyl proline biosynthesis (Zhang, 2013; Pastori *et al.,* 2003; Smirnoff, 2011). Furthermore, the endogenous level of AA has recently been suggested to be important in the regulation of developmental senescence and plant defence against pathogens (Pastori *et al.,* 2003; Barth *et al.,* 2004; Pavet *et al.,* 2005).

In peanut, knowledge of physiological processes involved in yield formation is still limited. Information on physiological traits responsible for differences in yield performance among peanut genotypes is also lacking. Such information would promote a better understanding of the key processes of yield formation that could be used to determine appropriate strategies for varietal selection that could hasten yield improvement. The objectives of this study were to determine (i) the relationship between pod yield and physiological traits, (ii) the relationships of physiological traits of crop development, and (i) Evaluation the effect of methanol and ascorbic acid foliar application of on physiological traits of peanut under rainfed condition.

Materials and methods

Field experiment

In order to evaluation the effect of foliar application of methanol and ascorbic acid on physiological traits (crop growth rate, pod growth rate, partitioning factor and pod filling period) of peanut (*Arachis hypogaea* L. var.NC2) an experiment was conducted in agricultural research farm of Astaneh Ashrafiyeh (Township located in 37° 16' latitude and 49° 56' longitude, north of Iran) in 2013-2014. A completely randomized block design with three replication on a factorial experiment with two factors including four levels of methanol (0 (Control), 10, 20, and 30 volumetric percentage) and four levels of ascorbic acid (0 (Control), 1000, 2000, and 3000 g/lit) was used. To each one of these methanol application practices, 1 g/lit tetrahydrofolate was added as catalysts. The Methanol and ascorbic acid foliar application was done two times during the growing season with 15 days intervals and spraying start in 73 code stage of BBCH-scale (Meier, 2001). Foliar application of methanol and ascorbic acid were made with a backpack sprayer between 17:00 and 19:00 p.m. at the beginning of peanut pod and seed growth stages, in both years.

Physiological traits

Crop growth rate, pod growth rate and partitioning factor and partitioning factor were calculated using the following equation (Wiliams, 1992).

$$CGR = \text{Haulm yield} + (\text{pod yield} \times 1.65)/T1$$
$$PGR = (\text{pod yield} \times 1.65)(T1\text{-}T2\text{-}15).$$

T1 is the number of days from sowing to harvest and T2 is the duration from sowing to 50% flowering. Shelling percentage was calculated by dividing of seed weight to pod weight.

$$PF = PGR/CGR.$$
$$PFP = \text{Pod yield}/PGR$$

Statistical analyses

The SAS software package was used to analyze all data (SAS 9.2) and means were compared by the least significant differences (LSD) test at 0.05 probability level. SPSS program was used for stepwise regression and correlations between examined parameters. In stepwise regression analysis, grain yield used as dependent variable, and the other studied traits were use as independent variables.

Results

Crop Growth Rate (CGR)

With attention to results of data variance analysis table (Table 1), the effect of methanol and ascorbic acid foliar application and theses interaction effect showed significant differences at 1%, 1% and 5% probability level respectively, on crop growth rate. But effect of year and other interaction effect treatments were non-significant (Table 1).

Tablele 1. Analysis of variance (mean square and significance) for effect of methanol and ascorbic acid foliar application on physiological traits of peanut under rainfed condition.

S.O.V	Df	Crop Growth Rate	Pod Growth Rate	Partitioning Factor	Pod Filling Period
Year (Y)	1	2.4512	0.1335	256.27**	181.3075**
Y (R)	4	1.4400	2.0894	25.3784	14.8899
Methanol (M)	3	27.5777**	29.0427**	46.4846*	33.2454**
Y×M	3	0.8687	0.7624	33.6305	1.2105
Ascorbic acid (AsA)	3	12.4514**	11.5566**	8.7955	25.2016**
Y×AsA	3	0.1624	0.0902	8.9611	0.0695
M×AsA	9	2.7960*	2.8923	13.6868	0.1466
Y×M×AsA	9	0.3087	0.5339	11.6871	0.0384
Error	60	1.3672	1.5442	19.8865	0.5875
Cv (%)		11.48	13.26	4.85	1.62

* and ** significant at level of 5 and 1%, respectively. Values that do not have any symbol are non-significant.

Results showed that, with increasing concentration of methanol foliar application on plants the crop growth rate positively increased (Table 2). Between methanol foliar application levels, the highest amount of crop growth rate were obtained from M20 and M30 treatments (20-30 v/v) with 10.79 and 11.30 g/m².day respectively. Also, the lowest crop growth rate with 8.90 g/m².day was found from M0 treatment (control). Results showed that, with increasing concentration of ascorbic acid foliar application on plants the crop growth rate positively increased (Table 2). Between ascorbic acid foliar application levels, the highest amount of crop growth rate were obtained from AsA2000 and AsA3000 treatments (2000-3000 g/lit) with 10.99 and 10.48 g/m².day respectively. Also, the lowest crop growth rate with 9.31 g/m².day was found from AsA0 treatment (control). With attention to interaction effect of methanol × ascorbic acid foliar application on crop growth rate (Figure 1), the highest amount of crop growth rate were obtained from M10AsA2000, M10AsA3000, M20AsA1000, M20AsA2000, M20AsA3000, M30AsA0, M30AsA1000, M30AsA2000 and M30AsA3000 treatments. The lowest crop growth rate was recorded from M0AsA0, M0AsA1000 and M0AsA0 treatments. Positive and significant correlations ($p<0.01$) were found among PGR (r= +0.954**) and PF (r= +0.274**) with CGR according to the two-year results of the research, as seen in table 3. But PFP (r= -0.373**) showed significant negative correlation with CGR.

Pod Growth Rate (CGR)

With attention to results of data variance analysis table (Table 1), the effect of methanol and ascorbic acid foliar application showed significant ($p\leq0.01$), on pod growth rate. But effect of yea, interaction effect of methanol × ascorbic acid foliar application and other interaction effect treatments were non-significant (Table 1). Results showed that, with increasing concentration of methanol foliar application on plants the pod growth rate positively increased (Table 2). Between methanol foliar application levels, the highest amount of pod growth rate were obtained from M20 and M30 treatments (20-30 v/v) with 9.92 and 10.57 g/m².day respectively. Also, the lowest pod growth rate with 8.07 g/m².day was found from M0 treatment (control). Results showed that, with increasing concentration of ascorbic acid foliar application on plants the pod growth rate positively increased (Table 2).

Tablele 2. Comparison of mean effect of methanol and ascorbic acid foliar application on physiological traits of peanut under rainfed condition.

Treatment	Crop Growth Rate	Pod Growth Rate	Partitioning Coefficient	Reproductive Duration
Year				
2013	10.02 a	9.41 a	93.43 a	45.75 b
2014	10.34 a	9.33 a	90.16 b	48.54 a
LSD	0.47	0.50	1.82	0.31
			Methanol (v/v)	
M0	8.90 c	8.07 c	90.59 b	48.45 a
M10	9.76 b	8.91 b	90.95 b	47.79 b
M20	10.79 a	9.92 a	91.92 ab	46.61 c
M30	11.30 a	10.57 a	93.70 a	45.82 d
LSD	0.67	0.71	2.57	0.44
			Ascorbic acid (mg/lit)	
AsA0	9.31 c	8.50 c	90.91 a	48.52 a
AsA1000	9.95 bc	9.17 bc	92.07 a	47.31 b
AsA2000	10.99 a	10.10 a	91.91 a	46.72 c
AsA3000	10.48 ab	9.70 ab	92.27 a	46.11 d
LSD	0.67	0.71	2.57	0.44

Means, in each column, with similar letters are not significantly different at the 5% probability level. (1: First foliar application, 2: Second foliar application).

Between ascorbic acid foliar application levels, the highest amount of pod growth rate were obtained from AsA2000 and AsA3000 treatments (2000-3000 g/lit) with 10.10 and 9.70 g/m².day respectively. Also, the lowest pod growth rate with 8.50 g/m².day was found from AsA0 treatment (control). Positive and significant correlations ($p<0.01$) were found among CGR ($r= +0.954^{**}$) and PF ($r= +0.548^{**}$) with CGR according to the two-year results of the research, as seen in table 3. But PFP ($r= -0.477^{**}$) showed significant negative correlation with PGR.

Partitioning Factor (PF)

The highest partitioning factor of peanut obtained in the first year with 1.67 %. With attention to results of data variance analysis table (Table 1), the effect of year and methanol foliar application showed significant differences at 1% and 5% probability level respectively, on partitioning factor. But effect of yea, interaction effect of methanol × ascorbic acid foliar application and other interaction effect treatments were non-significant (Table 1). Results showed that, with increasing concentration of methanol foliar application on plants the partitioning factor positively increased (Table 2). Between methanol foliar application levels, the highest amount of partitioning factor were obtained from M20 and M30 treatments (20-30 v/v) with 91.92 and 93.70 % respectively. Also, the lowest partitioning factor with 90.59 and 90.95 % were found from M0 (control) and M10 treatments. Positive and significant correlations ($p<0.01$) were found among CGR ($r= +0.274^{**}$) and PGR ($r= +0.548^{**}$) with CGR according to the two-year results of the research, as seen in table 3. But

PFP (r= -0.501**) showed significant negative correlation with PF.

Pod Filling Period (PFP)

With attention to results of data variance analysis table (Table 1), the effect of methanol and ascorbic acid foliar application showed significant ($p \leq 0.01$), on pod filling period. But effect of yea, interaction effect of methanol × ascorbic acid foliar application and other interaction effect treatments were non-significant (Table 1). Results showed that, with increasing concentration of methanol foliar application on plants the pod filling period positively reduced (Table 2). Between methanol foliar application levels, the lowest amount of pod filling period were obtained from M30 treatment (30 v/v) with 45.82 day. Also, the highest pod filling period with 48.45 day was found from M0 treatment (control). Results showed that, with increasing concentration of ascorbic acid foliar application on plants the pod filling period positively reduced (Table 2). Between ascorbic acid foliar application levels, the lowest amount of pod filling period were obtained from AsA3000 treatment (3000 g/lit) with 46.11 day. Also, the highest pod filling period with 48.52 day was found from AsA0 treatment (control). Negative and significant correlations ($p<0.01$) were found among CGR (r= -0.373**), PGR (r= -0.477**) and PGR (r= -0.504**), with PFP according to the two-year results of the research, as seen in table 3.

Table 3. Simple correlation between physiological traits in peanut leaves.

Parameter	CGR	PGR	PF	PFP
CGR	1			
PGR	0.954**	1		
PF	0.274**	0.548**	1	
PFP	-0.373**	-0.477**	-0.504**	1

* and ** significant at level of 5 and 1%, respectively. (1: First foliar application, 2: Second foliar application).

Table 4. Stepwise regression for grain yield (dependent variable) and physiological traits (independent variable).

Step	1	2	3	4
Interpret the Constant	-76.619	-1726.142	-1547.360	-9036.389
CGR			68.622	722.226
PGR	287.321	307.099	240.187	-489.240
PF				81.491
PFP		31.045	25.728	29.670
Coefficients of determination (R^2)	0.92	0.94	0.94	0.95

Relationship between grain yield and physiological traits

Stepwise regression for grain yield (dependent variable) and physiological traits (independent variable) were presented in table 4.

Model 1: Grain yield= -76.619 + 287.321 (PGR); R2: 0.92.

Model 2: Grain yield= -1726.142 + 307.099 (PGR) + 31.045 (PFP); R2: 0.94.

Model 3: Grain yield= -1547.360 + 68.622 (CGR) + 240.187 (PGR) + 25.728 (PFP); R2: 0.94.

Model 3: Grain yield= -9036.389 + 722.226 (CGR) - 489.240 (PGR) + 81.491 (PF) + 29.670 (PFP); R2: 0.95.

Figures 2-5 showed that the relationships between seed yield and physiological traits of peanut. The higher seed yield, the higher CGR, PGR and PF will be and vice versa. The higher seed yield, the lower PFP will be and vice versa. The regression lines (Figures 2-5) showed that these variables are linearly related with each other. The R^2 values for CGR, PGR, PF and PFP were 0.89, 0.92, 0.20 and 0.12, respectively.

Discussion

Three physiological processes including partitioning of the assimilate between the reproductive and vegetative structures, the length of the pod filling period and the rate of the pod establishment best explain the variation in peanut yield (Duncan *et al.,* 1978; Williams, 2000). The heritability estimates for Crop Growth Rate (CGR), Pod Growth Rate (PGR), Partitioning Coefficient (PC) and Reproductive Duration (RD) were therefore investigated in a segregating population of peanut to understand if there is useful genetic variation for these traits and these traits could be used as selection criteria for yield in early mature peanut genotypes.

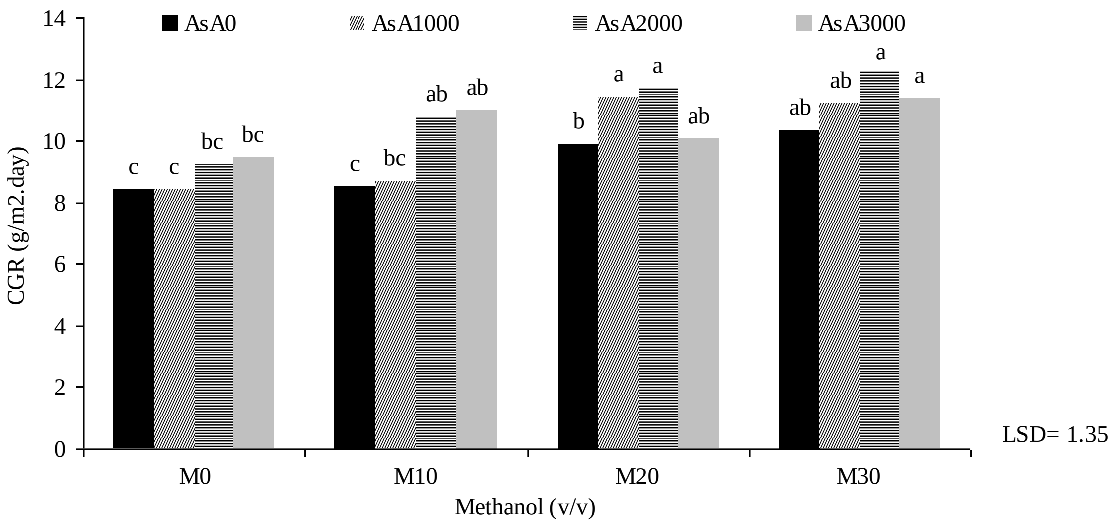

Fig. 1. Interaction effect of methanol × ascorbic acid foliar application on CGR.

The crosses were rather similar for pod growth rate and selection for high pod growth rate in these peanut crosses would not be effective. However, selection among cross would be possible for high crop growth rate, high partitioning coefficient and low reproductive duration because there were significant differences among crosses. Exploitation of variances among crosses and selection of superior genotypes using variances within crosses would be a possible strategy in this peanut population (Jogloy *et al.,* 2011). Jogloy *et al.* (2011) with the study of heritability and correlation for components of crop partitioning in advanced generations of peanut crosses reported that, the highest correlation coefficients were observed for PGR and PC (0.84** for phenotypic and 1.00** for genotypic). The relationship between PGR and CGR was positive and high (0.69** for phenotypic and 1.00** for genotypic). However, the relationship between PC and CGR though significant was positive but rather low (0.23** for phenotypic and 0.26** for genotypic). Significant and converse relationships between reproductive duration with crop growth rate, pod growth rate and partitioning coefficient, but the relationships were rather weak with low correlation coefficients ranging from -0.26** to -0.37** for phenotypic correlations and -0.30** to -0.45** for genotypic correlations (Jogloy *et al.,* 2011). Crops need duration of growth and good partitioning of assimilates to economic yield obtain high yield. In case of limited crop duration, yield depends largely on partitioning of assimilates, including partitioning between reproductive and vegetative structures, the period to pod filling and the rate of pod establishment (Duncan *et al.,* 1978). In the initial growth period, the Cop Growth Rate (CGR) was dependent on the leaf area index (LAI); in the late growth period the CGR was dependent on the Net Assimilation Rate (NAR) and the Pod Growth Rate (PGR) depended on the NAR (Aboagye *et al.,* 1994).

Seed number was positively related ($p<0.01$) to CGR ($R2 = 0.66$) and to PGR ($R2 = 0.72$) during the R3-R6.5 phase (seed number determination window), while crop growth during the grain-filling phase (i.e., between R6.5 and final harvest) was positively associated with grain number ($R2 = 0.80$, $p<0.001$) (Haro *et al.,* 2007). They also found that seed number is generally associated with seed yield rather than weight of individual seeds.

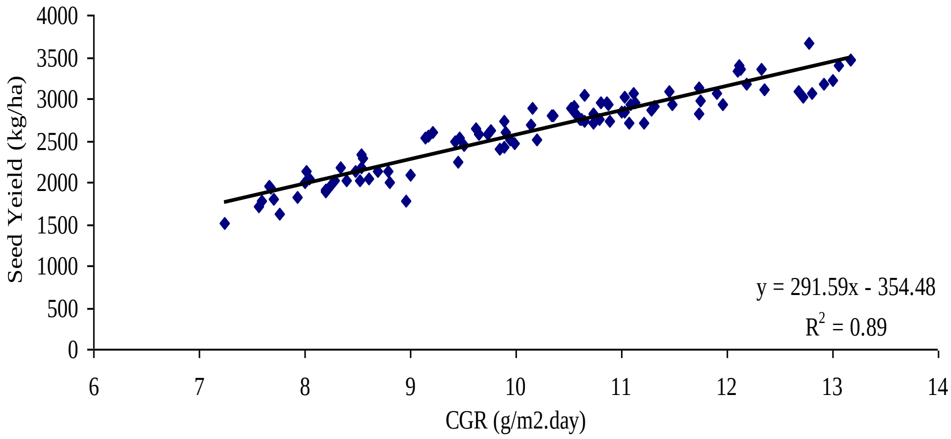

Fig. 2. Relationship between seed yield and CGR of peanut.

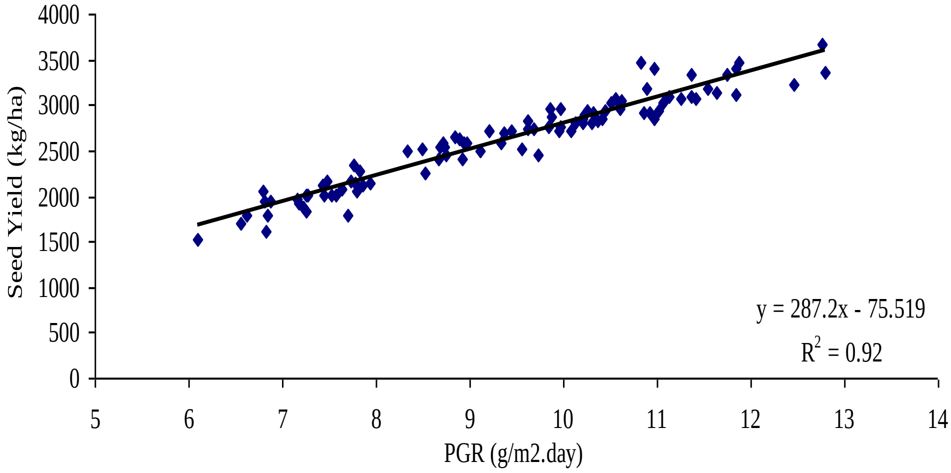

Fig. 3. Relationship between seed yield and PGR of peanut.

The previous results indicated that PGR and CGR are heritable and can be used as selection criteria for yield improvement. Furthermore, a better understanding on the genetic linkages among these characters can help peanut breeders to formulate appropriate breeding strategies to achieve breeding objectives. However, limited information is available on the heritability of these traits. Ntare and Williams (1998) found in peanut that heritability for crop growth rate, partitioning and reproductive duration was not as high as for yield. Haro *et al.* (2015) with the study of heritability and correlation for components of crop partitioning in advanced generations of peanut crosses reported that, The introduction of CPGH produced a lengthening (31%) of peanut growth cycle (S–R8), which was more pronounced for the reproductive phase (+39% for R1–R8) than for the vegetative phase (+17% for S–R1). This trend held for pod-set (R3–R6.5: +37%) and seed filling (R5–R8: +57%) subphases. It also held (CPGH > CEGH) for the rate of flower production (+80%), total flower number (+36%) and number of pods per plant (+117%), and consequently for the fertility index (+56%). The enhanced seed number of CPGH was related to ($r2 = 0.55$, $P < 0.001$) the variation in crop growth rate during the seed set period (CGRR3–R6.5), but not to the duration of this period. Variations in CGRR3–R6.5 were partially explained by differences in cumulative IPAR, which were linked to the duration of the R3–R6.5 period as well as to maximum light interception fraction. These trends may have management as well as breeding origins. Introduction of the procumbent habit enhanced seed weight (CPGH > CEGH) and seed-filling duration markedly, but had no effect on seed-filling rate. Seed weight, however, was positively related to this rate ($P < 0.01$) and exhibited a negative trend in response to the duration of the period. Lack of source limitations on seed filling suggest that future breeding efforts should focus on the increase of seed numbers and the reduction of seed filling duration (Haro *et al.,* 2015).

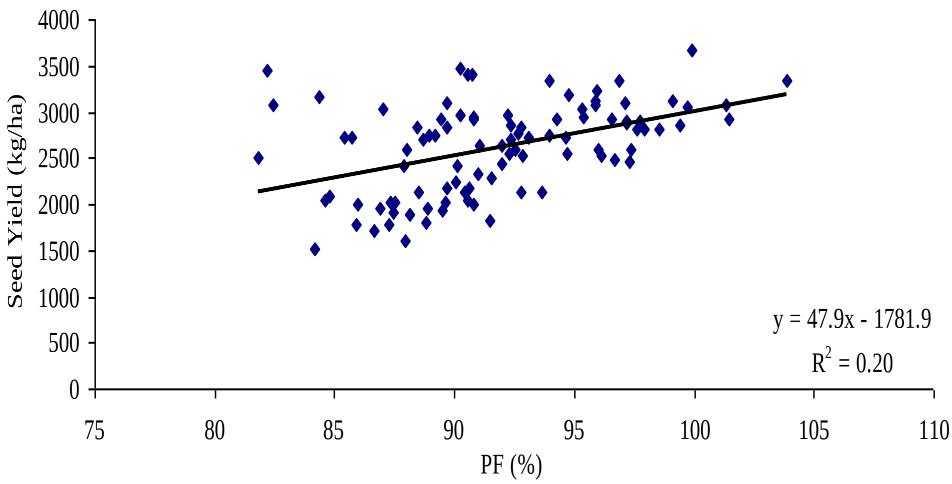

Fig. 4. Relationship between seed yield and PF of peanut.

Partitioning of dry matter is therefore regarded as the distribution of dry matter between the organs of plant or as the distribution between different processes (e.g. synthesis and hydrolysis of sugars, export, respiration etc.). It is the end result of the flow of assimilates from source organ via a transport pathway to sink organs. The partitioning among the sinks of a plant is primarily regulated by sinks themselves. The effect of source strength on the assimilated partitioning is often not direct one, but indirect via the formation of sink organs. Although, the translocation rate of assimilate may depend on the transport path but the later is only of minor importance for the regulation of DM partitioning. Source-sink relationship and the regulation of carbon allocation determine the crop yield. The growth of individual organs may be restricted by assimilate availability/source limitation or by organs ability to utilize assimilates/sink limitation (Patrick, 1988). Source and sink limitations may be separated in time so that organ growth is primarily source linked at certain periods during development and primarily sink limited at other time (Sharma and Sardana, 2012). Today, the use of plant growth regulators to reduce the negative impacts of stress has been proposed. Ascorbic acid and methanol as these materials can cause stress tolerance in plants. Growth regulating substances/growth regulators are known to influence a wide array of physiological parameters like alteration of plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions), enhancing nitrogen metabolism, promotion of flowering, uniform pod formation, increased mobilization of assimilates to defined sinks, improved seed quality, induction of synchrony in flowering, and delayed senescence of leaves (Verma *et al.,* 2009; Sharma *et al.,* 2013). These growth regulators, when applied as foliar spray at proper crop growth stage in optimum concentration could play a significant role in increasing crop yield and quality of produce in different field crops (Nagasubramaniam *et al.,* 2007; El- Shraiy and Hegazi, 2009; Maboko and Du Plooy, 2015; Pan *et al.,* 2015). These plant growth regulators have been considered as software for plant development and improvement in crop productivity (Malik, 1995; El- Shraiy and Hegazi, 2009; Maboko and Du Plooy, 2015; Pan *et al.,* 2015). The results in this research indicated, Foliar application of plant growth regulators such as methanol at 20-30 v/v, and Ascorbic acid at 2000-3000 mg/lit, was found to influence different physiological traits of peanut under rainfed condition, such as crop growth rate, pod growth rate, partitioning factor and pod filling period. They also found that, Correlation coefficients among crop growth rate, pod growth rate and partitioning factor were positive and significant, whereas they were negatively and significantly correlated with pod filling period. Foliar application of methanol and ascorbic acid increases crop growth rate, pod growth rate, partitioning factor were corresponded with our results (Abbasian *et al.,* 2014; Abido *et al.,* 2015; Babaei *et al.,* 2014; Chattha *et al.,* 2015; Meena *et al.,* 2013; Soghani *et al.,* 2014).

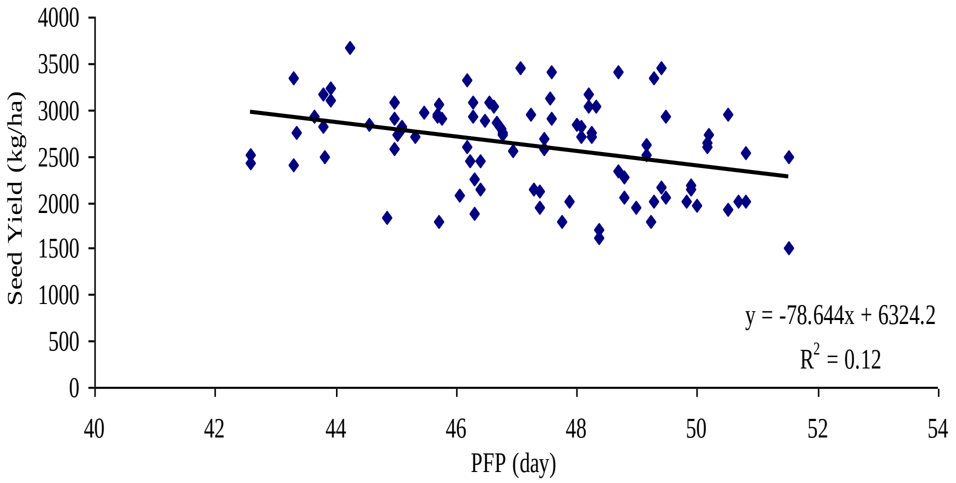

Fig. 5. Relationship between seed yield and PFP of peanut.

Conclusion

The results indicated that, the application of methanol and ascorbic acid in different concentrations showed significant increases in all physiological traits (apart from PFP) compared with control treatment. Correlation coefficients among crop growth rate, pod growth rate and partitioning factor were positive and significant, whereas they were negatively and significantly correlated with pod filling period. The results suggested that improvement of CGR, PGR and PF would be possible among studied materials and would result in lower reproductive duration and early maturity.

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