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Research Article

STUDIES ON WATER DIFFUSIVITY IN SOYBEAN SEED DURING GERMINATION

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Abstract- A laboratory experiment was conducted during 2014-15 at Department of Soil science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani using different six soybean cultivars to study the water diffusivity value for germination of soybean varieties under different soil types. The pot culture experiment was laid out on clayey, loamy and sandy soil with six soybean cultivars as treatments replicated thrice in randomized block design. The six soybean cultivars *viz.* JS-335, MAUS-71, MAUS-158, MAUS-162, MAUS-504 and MAUS-609 were used at two moisture levels at 50 per cent and 100 per cent field capacity. The results indicated that parameters like seed germination percentage, seed hydration value and seed germination rate were significantly influenced due to different soil moisture levels for different cultivars under study. Amongst six cultivars, JS-335 showed lowest germination percentage while MAUS-162, MAUS-504 and MAUS-609 showed maximum germination percentage in all three soil types. Amongst the clay, loam and sandy soils loam soil found better in supplying the soil moisture for seed germination.

Keywords- Soybean, Water diffusivity, Seed hydration and Seed Germination.

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Introduction

The soil water matric potential at which seeds can absorb enough water to germinate varies with species [1] and decrease in soil water matric potential reduces both germination rate and the final germination percentage. Soil water affects the germination process through water absorption. Under restricted water absorption, seeds may take longer time for germination and the seedling may lack uniformity [2] When planted under moisture constraint, viable seeds are sometimes slow or fail to germinate and the crop stand will consequently be poor. One of the most important parameters affecting seed germination is water diffusivity. Therefore it was felt essential to study the water diffusivity in soybean seeds.

Materials and Methods

The present investigation was conducted using three soil types *viz.* clayey, loamy and sandy soils having pH 7.7, 8.58 and 7.9, field capacity 36.0, 24.33 and 15.40 per cent, respectively and at two moisture levels 50 and 100 per cent field capacity. The details about soil properties of experimental soils are given in [Table-1]. Six soybean varieties *viz.* JS-335, MAUS-71, MAUS-158, MAUS-162, MAUS-504 and MAUS-609 were evaluated for their germination in different soil types and soil moisture levels. Twenty healthy seeds of each of the six cultivars of soybean were placed in petri dishes containing 200 gm of the soil at a depth of 10 mm at 28° ± 1° C. The experiment was replicated thrice. The germination was defined when 2 mm long radical sprouted from the seed coat. The data on germination percentage were analysed statically. The time of germination was considered by recording germination percentage upto 96 hours.

Result and discussion

The absorption of water by all seeds during germination increased as the moisture content increased as the moisture content increased in soil [Table-2]. The time required for germination was less in soil at 100 per cent field capacity than in 50 per cent field capacity. The increase in water absorption was owning to faster water intake at higher moisture content in the soil. It is ascribed to the increased surface area of seed in contact with water for longer period in distilled water than in the soil [3]. [4] observed that the rate of germination is affected as long as water potential is higher than a critical value which is species specific.

Water diffusivity in the seeds of six cultivars at the 50 per cent and 100 per cent field capacity contents increased with an increase in the time after planting the seed in soil and water diffusivity decrease in the amount of moisture in the soil.

The data reported in [Table-2] shows variations in germination percentage in different varieties of soybean in clay soil at 50 per cent field capacity. The MAUS-504 and MAUS-162 showed maximum percent germination to the tune of 60 per cent and 55 per cent, respectively followed by MAUS-609. The low moisture percentage of clay soil delayed the germination of all varieties of soybean. The cultivar MAUS-158 recorded lower percentage of germination (25 per cent), when moisture was limiting (50 per cent field capacity).lower soil water potential decreases the availability of water to the seeds and time required for imbibition of water to move to the seed increases. The [5] reported that if the rate of water to the seed is decreased as taken more time as the soil dries. Consequently, the rate of germination decreases. This is important for rainfed agriculture as the variation in rainfall is obvious leading to water availability to bring the seed hydration as described for germination.

The results on percent germination of soybean varieties are presented in [Table-3]

in clay soil at 100 per cent field capacity. The maximum germination (100 per cent) occured in MAUS-158, MAUS-162, MAUS-504 and MAUS-609 followed by MAUS-71 and JS-335 i.e. 95 per cent and 90 per cent respectively. This was attributed to optimum moisture content required for germination was available at 100% field capacity moisture and hence there was continuous film of water around the seeds [6].This showed that optimum availability of moisture is also one of the important factors that decides the germination of seeds. The further data showed that germination was more centralized between 24 to 36 hours under 100 per cent field capacity moisture level.

Table-1 *Mechanical and chemical composition of experimental soil.*

Sr. No.	Particulars	Unit	Soil types		
			Clay	Loamy	Sandy
1.	Coarse sand	Per cent	11.5	14.20	19.50
2.	Fine sand	Per cent	9.9	50.00	49.60
3.	Silt	Per cent	14.5	24.10	22.50
4.	Clay	Per cent	60.2	10.90	7.40
5.	pH		7.7	8.58	7.9
6.	EC	dSm^{-1}	0.06	0.16	0.25
7.	Organic carbon	$g\ kg^{-1}$	3.75	1.50	1.65
8.	Calcium carbonate	$g\ kg^{-1}$	80.0	34.0	32.0
9.	CEC	Cmol (p+) kg^{-1}	52.14	12.76	5.72
10.	Field capacity	Per cent	36.0	24.33	15.40

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Table-2 *Water diffusivity of soybean seeds when germinated in clayey, loamy and sandy soil at 50% field capacity.*

Sr No.	Cultivars	Clayey		Loamy		Sandy	
		Time of germination (hours)	Percent germination	Time of germination (hours)	Percent germination	Time of germination (hours)	Percent germination
1.	JS-335	72	30	48	75	44	50
2.	MAUS-71	56	30	44	95	40	85
3.	MAUS-158	56	25	40	95	44	95
4.	MAUS-162	76	55	36	100	48	100
5.	MAUS-504	76	60	64	100	60	100
6.	MAUS-609	80	50	48	100	60	100

Table-3 *Water diffusivity of soybean seeds when germinated in clayey, loamy and sandy soil at 100% field capacity.*

Sr No.	Cultivars	Clayey		Loamy		Sandy	
		Time of germination (hours)	Percent germination	Time of germination (hours)	Percent germination	Time of germination (hours)	Percent germination
1.	JS-335	36	90	20	90	56	65
2.	MAUS-71	36	95	36	75	44	90
3.	MAUS-158	40	100	44	80	48	85
4.	MAUS-162	32	100	28	100	52	95
5.	MAUS-504	40	100	36	100	60	100
6.	MAUS-609	32	100	36	100	52	100

The data presented in [Table-2] indicated the variation of percent germination of the different varieties of soybean in loamy soil containing soil moisture at 50 per cent field capacity. The seeds of MAUS-162, MAUS-504 and MAU-609 showed percent germination to the extent of 100% followed by MAUS-158 and MAUS-71 (95%). The variety JS-335 had lowest germination (75%) at 50 per cent field capacity. It is evident from the data that the genetic makeup, soil type and moisture characteristics of loamy soil are responsible for low germination. It was observed that in loamy soil even though the soil moisture was a limiting factor the soybean cultivars germination was 75 to 100 percent. However, it took nearly 48 hrs to germinate. This shows that even at 50 per cent field capacity, loamy soils are able to supply the moisture required for germination.

The results of percent germination of different soybean varieties in loamy soil at 100 per cent field capacity are presented in [Table-3]. The maximum germination (100 per cent) occurred in MAUS-162,MAUS-504, and MAUS-609 followed by JS-335 i.e. 90 per cent there being minimum of 75 per cent in MAUS-71. This may be due to optimum availability of soil water. It is general observance that the soil moisture above or below the field capacity affect the germination of seed. While studying the effect of excess water on the seedling emergence and seedling tolerance of groundnut, cotton, sorghum it was found that the per cent emergence of seedling was higher at field capacity than in case of flooding for 4, 8 or 12 days. [7] concluded that the tolerance to flooding was highest in groundnut followed by cotton and sorghum respectively.

The data presented in [Table-2] shows the variation in percent germination of the different varieties of soybean in sandy soil at soil moisture at 50 per cent field capacity. The seeds of MAUS-162, MAUS-504 and MAUS-609 showed 100 per cent germination followed by MAUS-158 (95 per cent). Minimum seeds were germinated in sandy soil having 7.70 percent soil moisture i.e. 50 per cent field capacity. Thus, it is inferred that, MAUS-162, MAUS-504 and MAUS-609 proved better in germination and compared to others in sandy soils. The germination of cultivar JS-335 was found to be affected negatively in sandy soil.

The data presented in [Table-3] showed variation in germination of different varieties of soybean in sandy soil at 100 per cent field capacity. The variety MAUS-504 and MAUS-609 had 100 per cent germination followed by MAUS-162 and MAUS-71 *i.e.* 95 per cent and 90 per cent respectively. The seeds of JS-335 recorded lower germination i.e. (65 per cent) in sandy soil. This may be due to coarse soil fraction which holds water for short period. [8] found that most seeds showed good germination over the entire range of available water. [9] reported that the rates as well as percent seedling emergence of soybean (J.S-2) were

maximum at the suction of -0.3 bar, although satisfactory emergence (greater than 70 per cent) occurred up to the suction of 3 bar. They also reported that percentage emergence of soybean sown at different depths decreased and the time required to reach maximum emergence increased with increase in moisture suction.

Conclusion

Amongst all cultivars JS-335 showed lowest germination percentage while MAUS-162, MAUS-504 and MAUS-609 showed maximum germination percentage in all soil types.

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