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Influence of moon rhythms on yield of carrot (*Daucus carota* L.), under biodynamic management

PEDRO JOVCHELEVICH[1]

Key words: moon rhythms, cronobiology, biodynamic agriculture, lunar phases

Abstract

The purpose of this work was to evaluate the influence of moon rhythms on yield of carrot roots under biodynamic management sowed in different dates. The experiment was carried out over a two period on a biodynamic farm, in Botucatu, São Paulo State, Brazil. Rhythms were tested observing the effects of seeding at different planting dates. The experiment was performed with four randomized blocks and 31 treatments (different dates) in 2005, and fourteen treatments in 2006. The harvest was made 82 days after sowing. Effects associated with planting at a specific lunar position were measured by the deviations from the trend curve. The following characteristics had been evaluated: fresh mass of roots and leaves and dry mass of roots. Dry mass was the only one that in the contrast between averages showed significant results in the two periods of the experiment. Result was that the synodic new phase was superior to the first quarter, and full phases and in the ethno synodic rhythm, the full phase was inferior to the other.

Introduction

Nowadays most of the people live in cities, and few can even recognize any constellation in the sky. The story of the great civilizations of the past shows the importance of astronomical rhythms, not only in agriculture but in all daily activities. This knowledge is disappearing, but it still remains in small farmers practice, like using the phases of the moon in agriculture, forestry and animal management. Biodynamic agriculture values this popular knowledge and also expands it, incorporating the rhythms of the moon and other planets move related to agricultural activities in general. In international biodynamic movement, the best known Agricultural Astronomical Calendar currently is from MariaThun, which is translated into several languages. She has systematically researched these interactions through experiments for almost 50 years. In this line, there are few researchers who have worked with cultivated plants.

Material and methods

The experiment was conducted on the farm Santo Antonio, from the biodynamic gardener Geraldo Joaquim Baldini, where carrots are grown in rotation with other vegetables. The property is located in Botucatu / SP, with the following coordinates: latitude 22º44'00"S and longitude 48º34'00"W, altitude 800 m. The climate is classified as Cwa mesothermal, humid subtropical with dry during winter, as the international system of Köppen (Setzer, 1946). The soil is a Ferralsol, medium texture. The experiment was carried out in randomized block design with 31 treatments, four replicates in 2005 and 14 treatments, four replicates in 2006. Each plot had the following dimensions 1.5 x 1.0 m with four rows of plants spaced 0.25 x 0.05 m with 120 plants per plot. Each block was composed of a bed divided into 31 shares in 2005, and 14 shares in 2006. The cultivar used was Brasilia carrots. All plots managed in the same way, according to the biodynamic management adopted by the producer, ie, fertilizing with biodynamic compost (with livestock) and crop residues, crop rotation and spread with biodynamic preparations manure (500) and silica (501).
The treatments consisted of different sowing dates, ranging from 5 May to 04 June 2005 and 25 April to 25 May in 2006, always performed between 13 and 15hs. Carrots were sown in beds of 1.0 m wide and 0.20 m high. The irrigation system was spray (average of 20 mm / day), and liming was not necessary, as the pH was above 5.5 and percent base saturation above 60%. We used manual seeder and covered with biodynamic compost (7500 kg / ha). The weeds were eliminated of the plots before sowing carrot.
At 27 DAG (days after germination) made up thinning the plants, to obtain a population of 20 plants per linear meter. The weeds control was manual, it there was no use of fertilization coverage and no pest control. The harvest was done 82 DAS (Days After Seeding), equivalent to three cycles of sidereal light (three cycles of 27.3 days). For the experiment we used only the central portions of the beds and plots, discarding the sides. Some plots were considered lost. eg.:24/5/05 day was discarded due to a rain of 95 mm. Other 10 plots were eliminated due to the action of dogs. In 2006 only 3 plots were discarded.

[1] Associação Brasileira de Agricultura Biodinâmica, Brasil
pedro.jov@biodinamica.org.br, www.biodinamica.org.br

The astronomical data of lunar rhythms used for correlation with production were extracted from Agricultural Astronomical Calendar (Thun, 2005 and 2006). For this we considered the astronomical data concerning the dates of sowing in relation to following lunar rhythms: Synodic moon rhythm (phases of the moon). Also considered the ethno moon phases, which does not include the traditional concept "phase", but indicates that the impulse starts three days before the traditional phase, up to three days after this (Restrepo-Riviera, 2005). Also evaluated the Agricultural Astronomical Calendar based on astronomical (not astrological) ephemeris. One of the fundamental principles of this calendar is related to the movement of the Moon through the twelve regions of the Zodiac (Sideric Moon Rhythm). The Zodiac is the set of constellations in front of which the moon and all the planets move, as it is observed from Earth. In each of these days the plants receive stimuli which act on the development of its various constituent parts: root (constellations of Taurus, Virgo and Capricorn), stems and leaves (constellations of Pisces, Cancer and Scorpio), flowers (constellations Gemini, Libra and Aquarius) and fruits (constellations of Aries, Leo and Sagittarius), and exert beneficial effects on them. (Thun, 2000).

The following characteristics were evaluated: Weight of Roots and leaves fresh, percentage of dry weight. Production data were used to calculate a polynomial equation. This equation produced a line that describe the general trend of effects that were due to planting at different times. The data for individual plantings were then compared with the trend line for all of the replicates. The percent deviation from the trend line was calculated. These values were then analyzed with a analysis of variance using the SAS statistical analysis program. It was verified the following contrasts between treatments:
a) Comparing the Phase of the Moon each other: full with new, crescent and waxing, new with waxing and crescent, crescent with waxing (for ethno moon phases were made the same contrasts that traditional stages) b) Rhythm ascending to descending c) with Perigee peak d) Node with ascending descending e) Comparing Root Day to leaf day, flower and fruit day (when the root carrot was evaluated), f) Comparing Root Day to leaf day, flower and fruit day for fresh mass of leaves; 3 days before the full moon and three days before the New Moon in 2005, and 1 day before the full moon and two days before the New Moon in 2006.

Results

Weight of roots fresh: The following effects were observed: the fresh root weight decreased in the later sowings (Figure 1). This occurrence was due to the increase of the cold and decrease hours of light / day during the fall and winter. Figures 2 refer to the seasonal trend values of fresh weight of root in 2005.

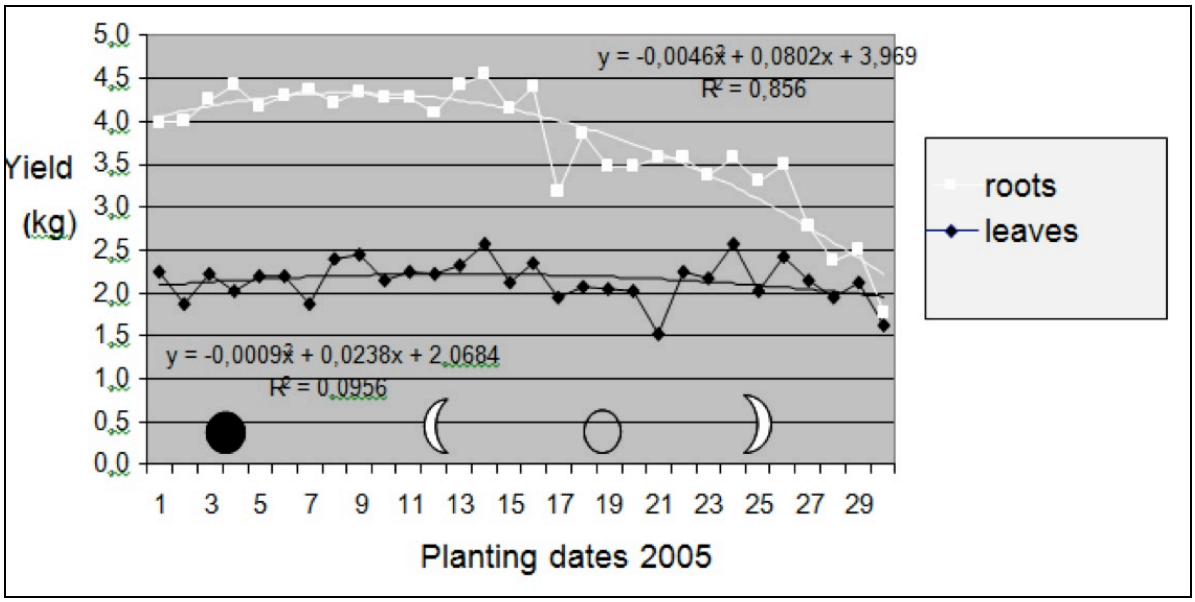

Figure 1. Weight of Roots and leaves fresh for different sowing dates seeding in 2005. Botucatu, UNESP, 2007.

Comparing the average fresh weight of roots, 2005, there was a significant difference (at 5% probability) at synodic ethno rhythm on the full moon with crescent and full with waxing. In 2006 data the average, there

was significant difference (significant at the 5% probability) between averages of fresh weight of roots only for the synodic ethno rhythm in new phase with waxing. In 2005, the full ethno phase was inferior than crescent and waxing. In 2006 these results did not happened again, and the new phase ethno was lower than waxing as can be seen in Table 1.

Other authors working with the carrot and using the seasonal trend values d different results. GOLDSTEIN (2000), in an experiment in the USA, found that sowing the day before the full moon had the most positive effect, resulting in a 15% increase in productivity (significant at p = 1%). The sowing during the waxing moon reduced the productivity in 17% (significant at p = 2%). According to SPIESS (1994) the highest productivity was achieved with the carrot sown three days before the full moon, and at Virgo constellation, reaching up to 22% more productivity. The Moon in Sagittarius was when were obtained the lowest yield for carrots, showing the influence of synodic and sidereal rhythms in carrot cultivation.
Figures 2 refer to data from the seasonal trend values of fresh weight of leaves in 2005. These data are related to astronomical rhythms in 2005. The contrast between 2005 medium showed no significant difference(at 5% probability) in synodic ethno rhythm at the full with crescent phase and full with waxing.

Table 1 - The seasonal trend values (%) fresh root weight (FRW) and leaves (FLW) and root dry matter (DM) of carrots, related to various lunar rhythms, in 2005 and 2006. Botucatu - UNESP, 2007.

Lunar Rhythms	FRW 2005	FRW 2006	FLW 2005	FLW 2006	DM 2005	DM 2006
Synodic						
New	100,51	99,64	100,29	101,50	105,03	104,33
First quarter	100,20	100,52	101,35	105,12	98,03	96,69
Full	99,46	95,91	97,85	90,75	97,31	97,25
Last quarter	99,62	103,09	98,93	100,12	99,26	100,81
Before Full Moon	95,84	105,37	97,05	110,55	96,06	89,85
Before New Moon	98,89	103,81	99,19	96,97	93,15	95,04
Synodic ethno						
New ethno	97,52	93,88	95,79	98,39	100,05	98,60
First quarter ethno	102,52	100,52	104,65	102,71	102,27	104,20
Full ethno	93,74	96,96	91,58	93,39	95,85	93,37
last quarter ethno	105,50	110,58	105,78	103,17	101,41	103,70
Sideric						
Root	101,43	97,95	102,56	101,58	100,77	100,57
Fruit	95,41	94,69	91,91	95,55	99,20	98,76
Flower	103,15	102,16	103,25	100,00	101,20	95,20
Leaf	99,89	105,28	100,42	101,79	99,39	105,01

The contrast between average of fresh weight of leaves in 2006 showed no significant difference at 5% probability. The 2005 results repeats what happened with the fresh weight of roots in synodic ethno rhythm, related to the smallest value of the seasonal trend values of ethno full phase regarding crescent and waxing (Table 1).

Percentage of dry mass of roots
The collected data were related to astronomical rhythms in 2005 (Figures 2) and 2006. The contrast between the averages of dry matter (%), 2005 showed a significant difference at 5% probability in the following rhythms: synodic traditional: new phase with the waxing phase, crescent and full; At synodic ethno Rhythm**:** full phase with the crescent phase, new and waxing. The contrast between the averages of dry matter of 2006 showed a significant difference at 5% probability in the following rhythms: Traditional synodic rhythm: new phase with the phases of crescent and full; ethno rhythm: new phase with the phases of crescent, full and waning, full phase with crescent and waxing phases; At sideric rhythm, in trine root versus leaf and root/ fruit. Evaluating the syderic rhythm in 2006, it was observed that the value of the seasonal trend value of

trine leaf was superior to the root, and this one was superior to the fruit and flower. According THUN (2000) the root trine should be higher than the leaf, fruit and flower. The results of SPIESS (1994), which worked with MS% carrot, showed that root trines were also superior to the others. In 2005 there were no significant results.

To the synodic traditional rhythm in 2005, new phase was superior to other phases. In 2006 the results for new phase was superior of full and crescent, and equal to waxing phase (Table 1). As for contrasts in Synodic ethno Rhythm in 2005, the full phase showed the lowest result, while the other phases results were equal. In 2006, the full phase also had the lowest result, followed by the new. The crescent and waxing phases were similar but superior to the others (Table 1). Similar Result were found for weight of roots and leaves in 2005.

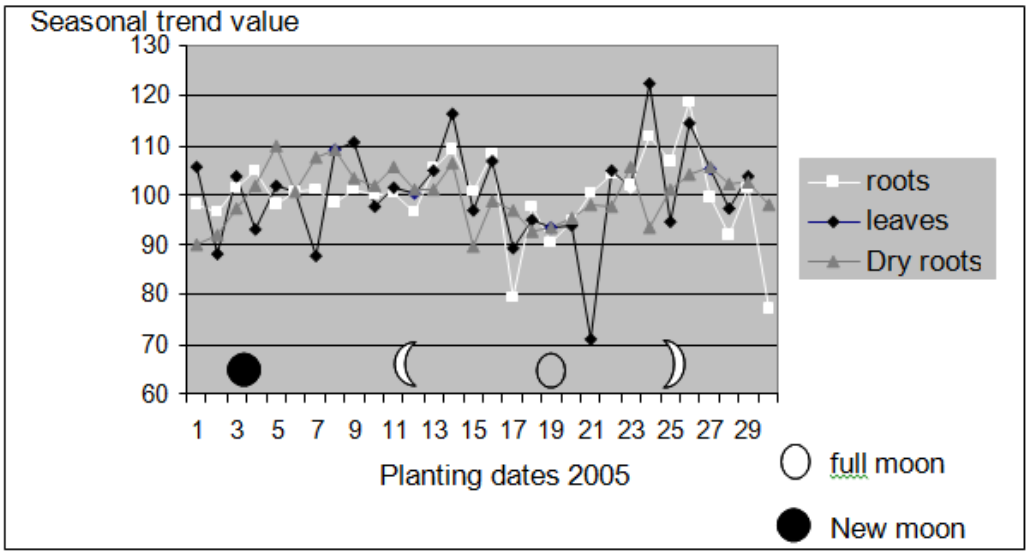

Figure 2. Weight of Roots and leaves fresh and dry weight of roots for different sowing dates in 2005 relative to the seasonal trend values. Botucatu, UNESP, 2007.

Discussion

The dry weight of roots was the only aspect that showed significant difference in the contrast between averages of the synodic traditional and synodic ethno rhythms in both periods of this study

In traditional synodic rhythm, the results on new phase of the moon was superior that on growing and full phases. In synodic ethno, the full phase was lower than the others. To sowing during the new moon period brings the best possible result to the producer. Precisely the rhythm of the moon phases is the most used by family farmers. The two-year research were not conclusive, but showed a tendency that demand more research. One of the aspects for future research is to increase the sowing period for at least three consecutive months.

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