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(54) Benævnelse: **Fremgangsmåde og anordning til beregning af justeringsparametre for en centrifugalspreder**

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METHOD AND DEVICE FOR CALCULATING ADJUSTING PARAMETERS OF A CENTRIFUGAL SPREADER

Description

The invention relates to a method for calculating adjusting parameters of a centrifugal spreader according to the preamble of Patent Claim 1 and to a device for adjusting such a centrifugal spreader according to the independent Patent Claim 8.

Centrifugal spreaders, which typically spread agricultural material from at least one, preferentially two spreader discs by means of typically two projection blades each arranged on the spreader discs have been the prior art for some time. By means of the projection blades arranged on the rotating spreader disc, the spread material is accelerated in the radial direction through the centrifugal forces that occur and spread in this way. The projection range and geometry of the spreading fan, i.e. the region in which the spread material is distributed, depends on highly diverse factors:

- The geometry of the spreader disc influences among other things the vertical discharge angle.
- The arrangement of the projection blade on the spreader disc as well as length and geometry of the projection blade influences the discharge speed and flight direction of the spread material.
- The condition of the spread material (grain size, grain geometry and density) influences the discharge speed and thus the projection range.
- The drop point of the spread material on the spreader disc influences the discharge speed and the horizontal discharge angle.
- The spreader disc rotational speed likewise affects the discharge speed.

The increasing precision in agricultural technology which aims at avoiding environmental loads and unnecessary costs and protecting resources, demands ever more detailed adjusting possibilities of the agricultural machines. For the centrifugal spreader this means, accordingly, that not only the quantity of the applied spread material and the spreader disc rotational speed is adjustable, but in the meantime the

drop point of the spread material on the spreader disc and the spreading blade geometry can be adapted. Special devices for distributing the spread material in edge regions of an agricultural area are also known.

Adjusting the various parameters is performed with the help of tables, formulas and/or graphs in which as a function of the spreading parameters, for example the spreader disc rotational speed for a certain spreader disc, projection blade and drop point, the mean horizontal discharge angle, i.e. the discharge angle relative to a line, which is drawn from the centre of the spreader disc against the travelling direction in the radial direction, and the mean projection range is indicated. Equally, tables, formulas and/or graphs can be available for the creation of which other variables were varied, kept constant and measured (DE 36 17 377 C2, DE 33 10 424 C2).

It is likewise state of the art to determine the discharge angle by means of sensors and according to the above tables, formulas and/or graphs perform adaptations on the mentioned parameters in the case of deviation from a predetermined set point value (DE 38 87 218 T2, DE 197 23 359 A1, EP 2 777 376 A2).

Since for maintaining predetermined set point values for projection range and discharge angle or according to working width, a lot of parameters have to be adjusted, corresponding measurements as basis of the above tables, formulas and/or graphs for the spread material concerned have to be carried out for all possible values of the relevant parameters, which is exceedingly time-intensive.

Accordingly, the object of the present invention is to make possible a simplification of the centrifugal spreader adjustment.

This is achieved through a method for calculating at least one adjusting parameter of a centrifugal spreader according to Claim 1, wherein the at least one adjusting parameter is calculated from a universal variable which at least partly characterizes the spread material and can be defined for any spread materials. In this way, based on the universal variable defining the spread material, an adjustment of the centrifugal spreader can take place and in particular if this variable is known for a concrete spread

material, the at least one adjusting parameter, by comparison with other spread materials, preferentially mean projection range or mean horizontal discharge angle or corresponding graphs and/or formulas can be adjusted without time-consuming measurement of the adjusting parameter for the predetermined set point values. Here, at least one of the variables characterizing the spread material, which is used for calculating the adjusting parameter of the centrifugal spreader for the desired working width, is defined by suitable measurement of one or more of the variables characterizing the flight behaviour of the spread material with the help of a suitable measuring rule, which is carried out with suitable means on the centrifugal spreader itself or a device arranged on the centrifugal spreader. By way of this, an automatic adjustment of the centrifugal spreader can be advantageously realized with unknown fertilizer properties.

In an advantageous configuration of the invention, the spreader disc type to be used and disc rotational speed is calculated from a variable characterizing the flight characteristics of the spread material. In this way, an adjustment of the adjusting parameters defining the projection range of the spread material, such as spreader disc rotational speed and/or spreader disc type and/or projection blade geometry can be carried out by means of a single variable, which reflects physical properties of the spread material such as preferentially density and/or mean grain size and/or grain geometry and/or cw-value and describes the flight characteristics of the spread material.

In an advantageous further development of the invention, peripheral conditions such as preferentially the desired working width and/or the projection range are included in the calculation. By way of this, the desired spreading pattern and with respect to this in particular the mean horizontal discharge angle and thus the working width and/or the projection range can be advantageously calculated by means of adjusting the at least one adjusting parameter merely by way of the characterizing variable.

In a further configuration of the invention, the drop point of the spread material on the spreader disc for a centrifugal spreader, which provides an adjusting possibility of the drop point of the spread material on the spreader disc, is calculated from a

variable characterizing the sliding properties of the spread material. In this way, the adjustment of the drop point can be attributed to a single variable characterizing the fertilizer at least partly, based on physical properties of the fertilizer, such as for example grain size and/or grain geometry and/or roughness.

In an advantageous further development of the invention, at least one of the variables characterizing the spread material, which is required for calculating the adjusting parameters of the centrifugal spreader for the desired working width, is defined by suitable measurement of one or more of the variables characterizing the sliding behaviour of the spread material with the help of a suitable measuring rule, which is carried out with suitable means on the centrifugal spreader itself or on a device arranged or carried along on the centrifugal spreader. By way of this, an automatic adjustment of the centrifugal spreader can be advantageously realized with unknown fertilizer properties.

Furthermore, the adjustment of the adjusting parameters of a centrifugal spreader is achieved through a device according to the independent Claim 8.

Further aspects of the invention are obtained from the remaining claims, the figures and the example description.

In the drawings

Fig. 1 shows schematically the adjusting procedure of a centrifugal spreader, in the case of which the horizontal discharge angle has to take up a set point value without general variables characterizing the fertilizer such as the sliding and/or flight characteristic being utilized and

Fig. 2 shows in schematic representation the adjusting of the centrifugal spreader with the help of general variables, which describe the sliding and the flight behaviour.

Typically, the adjusting parameters for the user of a centrifugal spreader are announced by the producer of the centrifugal spreader for a desired working width and a fertilizer

to be spread. For this purpose, the fertilizer is spread for example by way of testing in a measurement device with a centrifugal spreader that is identical to the model of the user and by way of testing, the working width and/or the mean horizontal discharge angle and/or the projection range for a set of adjusted parameters determined by means of catching elements. With popular fertilizers and centrifugal spreaders, which have been available on the market for a long time, it can also be sufficient to look in a suitable database. Based on this data, the adjustment of the centrifugal spreader is then carried wherein the type of the at least one spreader disc and the projection blades, the spreader disc rotational speed and the drop point in the process have to be determined and selected from a multitude of possible adjusting values and selection possibilities.

In the example shown in Fig. 1, the adjusting parameters spreader disc and projection blade type and disc rotational speed and a starting value for the drop point as well as a set point value for the discharge angle are given for a specific fertilizer type and given working width as described. Here, the starting value for the drop point serves as orientation aid for the starting drop point so as to obtain the desired discharge angle and thus the desired working width. By measuring the horizontal discharge angle, for example by means of radar sensors, a regulation of the same can now be additionally controlled in order to be able to adjust the working width as precisely as possible. Since an exact prediction of the discharge angle is difficult, it is advantageous to be able to react to possible deviations from the set point values by way of changes, preferentially of the drop point, by means of sensors. Reasons for the deviations can be for example inaccuracies in the prediction of the discharge angle but also external influences such as for example a distortion of the drop point because of an inclination during spreading operations on slopes. The latter could be detected and offset for example also through a suitable inclination sensor instead of the radar sensor. It is essential in this example that according to the previously popular procedure usually all adjusting parameters have to be looked up in a database or in the case of fertilizer or centrifugal spreader suppliers, had to be enquired or measured individually for each type of centrifugal spreader and for each type of fertilizer.

In contrast with this, merely two variables characterizing the fertilizer are now utilized according to the invention, as in the method shown in Fig. 2. In this example, this is

on the one hand the sliding behaviour and on the other hand the flight behaviour, which characterize the two phases defining the mean working width and the mean projection range, namely the sliding behaviour on the projection blade and the spreader disc and the flight behaviour following the departure from the projection blade or the spreader disc. In contrast with the procedure according to Fig. 1, these two properties are variables characterizing the fertilizer which do not in any way depend on the type of the centrifugal spreader. This means that with suitable tests and a suitably detailed characterization of the centrifugal spreader merely based on these two values, the adjusting values of the centrifugal spreader are known and can be applied without having to carry out elaborate and time-intensive spreading trials for this specific fertilizer type. Provided the centrifugal spreader is adequately characterized, indicating the same values for the sliding and the flight behaviour is adequate for each centrifugal spreader. Thus, merely a single test measurement of the fertilizer has to be carried out in each case for determining the sliding and the flight behaviour, for example at the fertilizer producer.

According to the example shown in Fig. 2, the sliding and the flight behaviour of the fertilizer is thus enquired for a certain fertilizer type in a database or from the supplier or producer, which, stating the desired working width by means of one or more algorithms and/or tables and/or graphs, then supply the adjusting values of the centrifugal spreader including the value for the intake system and the set point value for the horizontal discharge angle. On the one hand, this can be stored on a terminal assigned to the centrifugal spreader or an agricultural tractor and be suitably accessed or calculated. However, the values can also be determined by way of a program installed on any PC and/or mobile terminal device, in particular telephone or be provided by the producer of the fertilizer spreader, for example telephonically or via the internet or by email. The relevant adjusting values are preferentially adjusted on the centrifugal spreader before starting the spreading operation and in this example according to Fig. 1 the horizontal discharge angle measured with the help of sensors, preferentially radar sensors, compared with the set point discharge angle for achieving the working width and in the case of deviations the intake point of the spread material suitably readjusted.

When two different fertilizer types are at least approximately identical regarding sliding and flight behaviour, the adjusting values should also be adjusted approximately identically. For such a constellation, in accordance with the previous procedure, the fact that the adjusting values are at least approximately identical would have been known only after elaborate spreading trials.

In addition to this, it is obvious to derive relationships through investigations which serve for characterizing a centrifugal spreader in the form that from a few spreading trials spreading trials with certain adjusting values and fertilizers with certain sliding and/or flight behaviours, the discharge angle and/or the projection range for other adjusting values and/or other fertilizer types with other sliding and/or flight properties are definable so that in comparison with today's procedure, a far lower number of spreading trials for determining the adjusting values would be necessary. Provided that the sliding and the flight behaviour of a fertilizer were to be known by means of two measurements, the selection of all adjusting values of the centrifugal spreader for centrifugal spreaders which with respect to these two values are at least approximately characterized completely, would be immediately known uniquely and without further test measurements.

Advantageous configurations which relate to adjusting parameters of a centrifugal spreader other than the aforementioned are obviously conceivable.

PATENTKRAV

1. Fremgangsmåde til beregning af mindst en justeringsparameter for en centrifugalspreder, der har mindst en sprederskive, hvor den mindst ene justeringsparameter beregnes ud fra en universel variabel, som i det mindste delvist kendetegner spredningsmaterialet og bestemmes for ethvert ønsket spredningsmateriale,
kendetegnet ved, at
mindst en af variablerne, der karakteriserer spredningsmaterialet, der bruges til beregning af justeringsparametrene for centrifugalsprederen for den ønskede arbejdsbredde, bestemmes ved passende måling af en eller flere variabler, der karakteriserer spredningsmaterialets flyveadfærd ved hjælp af en passende måleregel, hvilken måling udføres ved hjælp af passende midler på selve centrifugalsprederen eller en anordning anbragt på centrifugalsprederen.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** den centrifugale skivetype og centrifugale rotationshastighed, der skal anvendes, beregnes ud fra en variabel, der karakteriserer spredningsmaterialets flyvekarakteristik.

3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved, at** grænsebetingelser, såsom fortrinsvis den ønskede arbejdsbredde og/eller projektionsområdet, er indarbejdet i beregningen.

4. Fremgangsmåde ifølge et af kravene 1 til 3 til en centrifugalspreder, der har mindst en sprederskive og en forskydningsanordning af faldpunktet for spredningsmaterialet på sprederskiven, **kendetegnet ved, at** spredningsmaterialets faldpunkt på sprederskiven beregnes ud fra en variabel, der karakteriserer de glidende egenskaber for spredningsmaterialet.

5. Fremgangsmåde ifølge mindst et af de foregående krav til en centrifugalspreder, der har mindst en sprederskive og en forskydningsanordning af spredningsmaterialets faldpunkt på sprederskiven, **kendetegnet ved, at** alle justeringsparametrene for centrifugalsprederen såsom fortrinsvis spredningsmaterialets faldpunkt på sprederskiven, skive rotationshastighed og centrifugalsprederens sprederskivetype, beregnes ud fra mindst to variabler, karakteriserende spredningsmaterialet og bestemmes for ethvert

ønsket spredningsmateriale der fortrinsvis beskriver flyvekarakteristik og spredningsmaterialets glideadfærd under hensyntagen til den ønskede arbejdsbredde.

6. Fremgangsmåde ifølge mindst et af de foregående krav, **kendetegnet ved, at** ved hjælp af passende sensorer, såsom fortrinsvis radarsensorer og/eller ultralydssensorer og/eller lasersensorer, ved hjælp af hvilke arbejdsbredden overvåges under bestemmelsen af udledningsvinklen for spredningsmaterialet, hvor spredningsmaterialets faldpunkt på sprederskiven justeres i tilfælde af afvigelser af arbejdsbredden fra den ønskede værdi.

7. Fremgangsmåde ifølge mindst et af de foregående krav, **kendetegnet ved, at** mindst en af variablerne, karakteriserende spredningsmaterialet, der anvendes til beregning af centrifugalsprederens justeringsparametre for den ønskede arbejdsbredde, bestemmes af passende måling af en eller flere variabler, karakteriserende den glidende adfærd for spredningsmaterialet ved hjælp af en passende måleregel, hvilken måling udføres ved hjælp af passende midler på selve centrifugalsprederen selv eller en anordning, der er arrangeret eller medbragt på centrifugalsprederen.

8. Anordning til justering af justeringsparametrene for en centrifugalspreder, der har mindst en sprederskive,
hvor den mindst ene justeringsparameter beregnes ud fra en universel variabel, som i det mindste delvist karakteriserer spredningsmaterialet og bestemmes for ethvert ønsket spredningsmateriale ved hjælp af et program, der midlertidigt eller permanent er gemt i en hukommelse på en jobcomputer, der er tildelt centrifugalsprederen eller til det trækkøretøj, hvortil centrifugalsprederen er tilknyttet,
kendetegnet ved, at
mindst en af variablerne, der karakteriserer spredningsmaterialet, som er nødvendig til beregning af centrifugalsprederens justeringsparametre for den ønskede arbejdsbredde, bestemmes ved passende måling af en eller flere variabler, der karakteriserer flyveopførslen for spredningsmaterialet ved hjælp af en passende måleregel, hvilken måling udføres på selve centrifugalsprederen eller en anordning, der er anbragt på centrifugalsprederen, og som udføres ved hjælp af passende midler og/eller justeringsorganerne nulstilles og/eller justeres i overensstemmelse med de nyligt bestemte justeringsparametre.

9. Anordning ifølge krav 8, **kendetegnet ved, at** sprederskivetypen og sprederskivens rotationshastighed der skal anvendes beregnes ved hjælp af det lagrede program ud fra en variabel, karakteriserende spredematerialets flyvekarakteristik.

10. Anordning ifølge krav 8 eller 9, **kendetegnet ved, at** grænsebetingelser, såsom fortrinsvis den ønskede arbejdsbredde og/eller projektionsområdet, er indarbejdet i beregningen.

11. Anordning ifølge mindst et af kravene 8 til 10 til en centrifugalspreder, der har mindst en sprederskive og en forskydningsanordning for spredningsmaterialets faldpunkt på sprederskiven, **kendetegnet ved, at** spredningsmaterialets faldpunkt på sprederskiven beregnes ved hjælp af et lagret program ud fra en variabel, der karakteriserer de glidende egenskaber for spredningsmaterialet.

12. Anordning ifølge mindst et af kravene 8 til 11 til en centrifugalspreder, der har mindst en sprederskive og en forskydningsanordning af faldpunktet for spredningsmaterialet på sprederskiven, **kendetegnet ved, at** justeringsparametrene for centrifugalsprederen såsom fortrinsvis faldpunkt for spredningsmaterialet på sprederskiven, skiverotationshastighed og sprederskivetype for centrifugalsprederen, beregnes ved hjælp af det lagrede program ud fra mindst to variabler, der karakteriserer spredningsmaterialet og bestemmes for ethvert ønsket spredningsmateriale, der fortrinsvis beskriver spredningsmaterialets flyvekarakteristik og/eller glideadfærd under hensyntagen til den ønskede arbejdsbredde.

13. Anordning ifølge mindst et af kravene 8 til 12, **kendetegnet ved, at** ved hjælp af egnede sensorer, fortrinsvis radarsensorer og/eller ultralydssensorer og/eller lasersensorer, ved hjælp af hvilke overvåges arbejdsbredden under bestemmelsen af spredningsmaterialets udledningsvinkel, spredningsmaterialets faldpunkt på sprederskiven styres, og i tilfælde af afvigelser af arbejdsbredden fra den ønskede værdi, bestemmes og/eller korrigeres de tilsvarende justeringsværdier ved hjælp af det lagrede program og anvendes i overensstemmelse hermed.

14. Anordning ifølge mindst et af de foregående krav 8 til 13, **kendetegnet ved, at** mindst en af variablerne, der karakteriserer spredningsmaterialet, hvilket er nødven-

digt til beregning af justeringsparametrene for centrifugalsprederen for den ønskede arbejdsbredde, bestemmes ved passende måling af en eller flere variabler, karakteriserende spredningsmaterialets glideadfærd ved hjælp af en passende måleregel, hvilken måling udføres på selve centrifugalsprederen eller en anordning arrangeret eller udført på centrifugalsprederen og er resultatet ved hjælp af passende midler og/eller justeringsorganerne nulstilles og/eller justeres i overensstemmelse med de nyligt bestemte justeringsparametre.

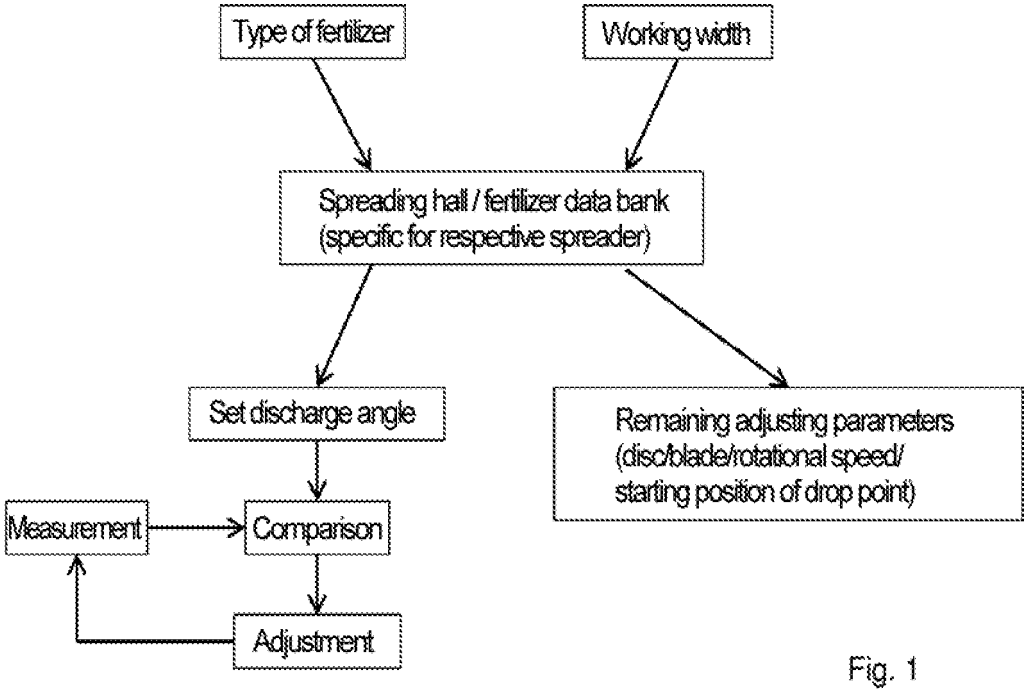
Type of fertilizer
Working width
Spreading hall / fertilizer data bank
(specific for respective spreader)
Set discharge angle
Remaining adjusting parameters
(disc/blade/rotational speed/
starting position of drop point)
Measurement
Comparison
Adjustment

Fig. 1

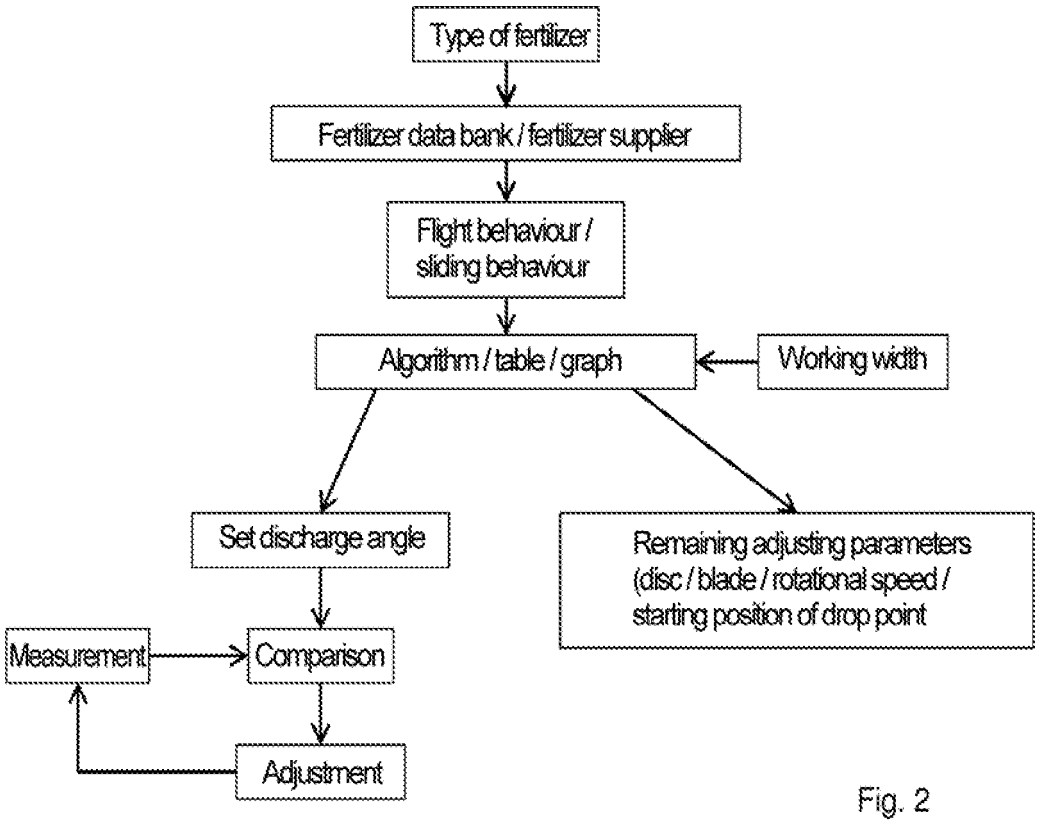
Type of fertilizer
Fertilizer data bank / fertilizer supplier
Flight behaviour / sliding behaviour
Algorithm / table / graph
Working width
Set discharge angle
Remaining adjusting parameters (disc / blade / rotational speed / starting position of drop point
Measurement
Comparison
Adjustment

Fig. 2